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Hardware Requirements Document
for the
Human Research Facility
Workstation

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for the

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Hardware Requirements Document
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Human Research Facility
Workstation

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CHANGE/ REVISION	DATE	DESCRIPTION OF CHANGE	PAGES AFFECTED
BASIC	3/25/99	BASELINE ISSUE	ALL
1	9/15/99	Change text in Section 7.2.3.1, "Acceptance Vibration Test," Deleted sub item e, of Section 3.1.5.3.2, "HRF Workstation to Other Payloads," by deleting sub item e., " ...floppy drive interface," requirement and renumbered the section; and updated No. 31 of the HRD Applicability Marix. Reference CCBD: HJ5A-B104-0001.	3-8, 7-2, and A-3
2	2/3/00	Changed "HRF WS Display" to "HRF Flat Screen Display" in Sections 3.1.1, 3.1.1.3,3.1.2.1.5, 3.1.2.1.6, 3.1.2.3, 3.1.2.5.2, 3.1.4.1.3, 3.1.4.2.2, 3.1.4.2.3 and Appendix B.	3-1, 3-3 thru 3-7, B-1 & B-2.
3	5/5/00	The line "COTS products shall not be held to these requirements" was deleted from Section 4.5.1.3. Reference CCBD: HLP1-HD1-000F3	4-3

Altered pages must be typed and distributed for insertion.

ABSTRACT

This document was prepared by Lockheed Martin Engineering & Sciences Company, for the National Aeronautics and Space Administration (NASA) Lyndon B. Johnson Space Center (JSC) under contract number NAS9-19100, sub task order number HSCE5HHF.

This document is the design specification and certification plan for the Human Research Facility (HRF) Workstation (WS) which is part of the HRF for the International Space Station (ISS).

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TABLES

ACRONYMS AND ABBREVIATIONS

°C	degrees Centigrade
°F	degrees Fahrenheit
1553B	Mil-Std-1553B protocol
A/D	Analog to Digital
ADP	Acceptance Data Package
AIT	Analysis and Integration Team
C&DH	Command and Data Handling
CCB	Configuration Control Board
CIL	Critical Items List
COTS	Commercial-Off-the-Shelf
CR	Change Request
CSCI	Computer Software Configuration Items
D/A	Digital to Analog
dB	Decibel
DCN	Drawing Change Notice
DOS	Disk Operating System
DR	Discrepancy Report
EEE	Electrical, Electronic and Electromechanical
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
EXPRESS	Expedite the Processing of Experiments to Space Station
FMEA	Failure Modes and Effects Analysis
FRD	Functional Requirements Document
g	Gravity
GB	gigabyte (approx. one billion bytes)
GFE	Government Furnished Equipment
GFS	Government Furnished Software
grms	Gravity root means squared
HRD	Hardware Requirements Document
HRF	Human Research Facility
HRP	Human Research Program
I/O	input/output
ICD	Interface Control Document
IDD	Interface Description Document
IRIG-B	Inter-Range Instrumentation Group Standard B
ISPR	International Standard Payload Rack
ISS	International Space Station
IVA	Intravehicular Activity
JHB	JSC Hand Book
JSC	Lyndon B. Johnson Space Center
JSCM	JSC Manual

kB	kilobyte (1024 bytes)
Kbps	kilobits per second
kg	kilogram
lbs	pounds
MB	megabyte (approx. one million bytes)
MHz	megahertz (thousand cycles per second)
MIL-ER	Military Established Reliability
MIL-STD	Military Standard (documentation)
MOTS	Modified Commercial-Off-the-Shelf
MS	Military Standard (parts)
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NHB	NASA Hand Book
NSTS	National Space Transportation System
NTSC	National Television Standards Committee
oct	octave
OS	Operating System
PC	Personal Computer, Portable Computer
PCMCIA	Personal Computer Memory Card Industry Association
PDA	Pre-delivery Acceptance Test
PIA	Pre-installation Acceptance
PRD	Program Requirements Document
psia	Pounds per Square Inch Absolute
psig	Pounds per Square Inch Gauge
PU	panel unit
PWB	Printed Wiring Board
QA	Quality Assurance
QAVT	Qualification Acceptance Vibration Test
QEPM&L	Qualified Electrical, Electronic, Electromechanical (EEE) Parts, Manufacturers, and Laboratories
QVT	Qualification Vibration Test
RAM	random access memory
RGB	Red, Green, Blue
RIC	Rack Interface Controller
S&MA	Safety and Mission Assurance
S/W	software
SAMMI	SSI (company name) Advanced Man-Machine Interface
SCCC	Software Configuration Control Center
SCSI	Small Computer System Interface
SDD	Software Design Document
SDP	Software Delivery Plan
SIR	Standard interface Rack

ACRONYMS AND ABBREVIATIONS (Cont'd)

SMACAR   Safety and Mission Assurance Certification Approval Request Form
SS   Space Station
SSP   Space Station Program

TBD   To Be Determined
TBS   to be supplied
TPS   Task Performance Sheet
TRR   Test Readiness Review
TT   Thermal Test

VDD   Version Description Document
VGA   Video Graphics Array (or Adapter)

W/S, WS   Workstation

1.0   <u>INTRODUCTION</u>

1.1   PURPOSE

The purpose of this Hardware Requirements Document (HRD) is to describe
and delineate the methods by which the National Aeronautics and Space
Administration's (NASA) Lyndon B. Johnson Space Center (JSC) will design,
develop, test, accept, and certify the Human Research Facility (HRF)
Workstation (WS) for the International Space Station (ISS) HRF. This
document was prepared by following the HRF HRD template, LS-71099, as
established by the HRF program.

1.2   SCOPE

The requirements established herein are applicable only to the HRF WS. This
HRD identifies unique, general construction, and environmental design
requirements in Sections three, four and five respectively. Section six identifies
the certification approach. For HRF, certification is defined as the combination
of acceptance and qualification. Sections seven and eight describe the
acceptance and qualification approach and tests respectively. Detailed facility
and functional test plans will be written separately for specific certification tests
as they are required. These detailed test plans (not necessarily formalized
documents) will include sections on specific test procedures, instrumentation
requirements, and test support fixture configuration.

The HRF WS classified as a Class C payload for the ISS. The governing
document shall be LS-71000, "Program Requirements Document for the Human
Research Facility."

2.0 APPLICABLE DOCUMENTS

The following specifications, standards, and publications are considered applicable to this HRD because they are each specifically called out in individual requirements in this HRD. No requirement will appear in this section without being referenced in a HRD requirements section. Revision letters shall accompany the document call-outs so that work authorization documents can be written from this HRD. If the HRF Master List of Documents is revised to reflect an updated document revision, the impact to this and all other HRF documentation will be assessed and any changes made via a Change Request (CR) processed through the HRF Configuration Control Board (CCB).

NOTE: If no revision is indicated, the basic release is implied.

2.1 SPECIFICATIONS

Document No.	Document Title
IPC-6011	Generic Performance Specification for Printed Boards
IPC-6012	Qualification and Performance Specification for Rigid Printed Boards
JSCSPEC-M-1B	Specification Marking and Identification
JSC-20793	Manned Space Vehicle Battery Safety Handbook
LS-60035	Life Sciences Flight Cable Fabrication Practices and Specifications
MIL-S-7742B Ch 1	Screw Threads, Standard, Optimum Selected Series, General Specification for
MIL-S-8879C Ch 1	Screw Threads, Controlled Radius Root With Increased Minor Diameter, General Specification for
MIL-S-19500J	Semiconductor Devices, General Specifications for
MIL-S-33540	General Specification for Liquid Locking Compounds
MS33540J Ch 1	Safety Wiring and Cotter Pinning, General Practices for
MSFC-SPEC-522B	Design Criteria for Controlling Stress Corrosion Cracking
NHB-5300.4(1F)	Electrical, Electronic, and Electromechanical (EEE) Parts Management and Control Requirements for NASA Space Flight Programs
NSTS-1700.7B Ch 2	Safety Policy and Requirements for Payloads Using the Space Transportation System

Document No.	Document Title
NSTS-1700.7B ISS Addendum	Safety Policy and Requirements for Payloads using the International Space Station
S312-P-003B	GSFC, Procurement Specification for Rigid Printed Boards for Space Applications and Other High Reliability Users
SE-M-0096A	General Specification for Materials and Processes, Requirements for JSC Controlled Payloads
SN-C-0005C	National Space Transportation System Contamination Control Requirements
SP-T-0023B	Specification Environmental Acceptance Testing
SSP-30237B	Space Station Electromagnetic Emission and Susceptibility Requirements
SSP-30245B	Space Station Electrical Bonding Requirements
SSP-30312F	Electrical, Electronic, and Electromechanical (EEE) and Mechanical Parts Management and Implementation Plan for Space Station Program

2.2   STANDARDS

Document No.	Document Title
IPC-2221	Generic Standard on PWB Design
IPC-2222	Sectional Standard on Rigid PWB Design
JPG-8500.4D	JSCM Engineering Drawing System Manual - Drawing Format, Requirements, and Procedures
JSC-23642C	JSC Fastener Integrity Testing Program
JSCM-8080	JSC Design and Procedural Standards Manual
MIL-STD-794E Ch 2	Parts and Equipment, Procedure for Packaging of
MIL-STD-810E	Test Method Standard for Environmental Engineering Considerations and Laboratory Tests
MIL-STD-975M	NASA Standard Electrical, Electronic, and Electromechanical (EEE) Parts List
NASA-STD-8739.3	Soldered Electrical Connections
NASA-STD-8739.4	Crimping, Interconnecting Cables, Harnesses and Wiring

Document No.	Document Title
NASA-STD-8739.7	Electrostatic Discharge Control (Excluding Electrically Initiated Explosive Devices)
SSP-50005B	International Space Station Flight Crew Integration Standard (NASA-STD-3000/T)
SSP-50007	Space Station Inventory Management System Label Specification

2.3   PUBLICATIONS

Document No.	Document Title
JHB-5322C	Contamination Control Requirements Manual
JSC-09604F	Materials Selection List for Space Hardware Systems
LS-30116	Specification and Assembly Drawing for the Virtual Environment Generator, P/N: SAD46113623
LS-71000	Program Requirements Document for the Human Research Facility
LS-71001A	Functional Requirements Document for the Human Research Facility
LS-71002	System Safety Program Plan for the Human Research Facility
LS-71005	Configuration Management Plan for the Human Research Facility
LS-71010 Draft 9/97	Fracture Control Plan for Human Research Facility Payload and Racks
LS-71011	Acoustic Noise Control and Analysis Plan for the Human Research Facility Payloads and Racks
LS-71012 Draft 9/97	Structural Analysis Plan for Human Research Facility Payload and Racks
LS-71016 Ch 1	Electromagnetic Compatibility Control Plan for the Human Research Facility
LS-71020 Ch 1	Software Development Plan for the Human Research Facility
LS-71020-1	Software Configuration Management Plan and Procedure for the Human Research Facility

LS-71022 Draft 12/95	Maintainability Plan for the Human Research Facility
LS-71026 Draft 10/97	Reliability Plan for the Human Research Facility
LS-71030 Draft 10/97	Quality Assurance Plan for the Human Research Facility
SSP-30234D	Instructions for Preparation of Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL) for Space Station
SSP-30423F	Space Station Approved Electrical, Electronic, and Electromechanical (EEE) Parts List
SSP-30512C	Space Station Ionizing Radiation Design Environment
SSP-50008B	International Space Station Interior Color Scheme
SSQ-25002A Ch 6	Supplemental List of Qualified Electrical, Electronic, Electromechanical (EEE) Parts, Manufacturers, and Laboratories (QEPM&L)

2.4   SELECTION OF SPECIFICATIONS AND STANDARDS

Specifications and standards necessary for design and development shall be selected in the following order of preference, except as otherwise specified in this document. The exact issue shown is to be used, unless otherwise specified in this document.

In the event of conflict, the order of precedence shall be:

1. LS-71000, Program Requirements Document (PRD) for the Human Research Facility
2. JSC Drawings number; SDG46115000, HRF WS Top Assembly
3. JSC Drawings number; SAD46113623, Virtual Environment Generator Top Assembly
4. NASA specifications and standards
5. Manned spacecraft criteria and standards
6. Federal specifications and standards
7. Military specifications and standards
8. Other governmental specifications and standards
9. Specifications released by nationally recognized associations, committees, and technical societies

3.0   UNIQUE DESIGN REQUIREMENTS

This hardware requirements section contains a general hardware system description (for reference) and the hardware system performance, load, physical (e.g., weight, envelope, etc.), interface and software design requirements. The Certification Matrix provided in Appendix B specifies the method of compliance for each of the following requirements.

3.1   HRF WORKSTATION

3.1.1   Description

The HRF WS is a key computational element in the data system architecture. Coordination with other HRF hardware will be maintained to ensure that sound programmatic decisions are made to obtain the most appropriate, state-of-the-art commercial computer system. The HRF WS is a stowed display, keyboard, archive media, cables and an active 4 PU drawer with electrical, mechanical, thermal and data interfaces to the Expedite the Processing of Experiments to Space Station (EXPRESS) Rack and ISS. The HRF WS will provide data collection, archive, downlink, display, video processing, graphics accelerator, user interface and EXPRESS Rack interface.

The HRF WS will be used to provide a platform for installing and executing HRF software to perform the various tasks required in experiment procedures. These tasks include, but are not limited to, command and control of HRF equipment, monitoring of the HRF Rack (through interface with the Rack Interface Controller (RIC)), experiment data collection and storage, crew notes, crew tests and HRF equipment tests. The unit may also be connected to one or several experiment drawers, outboard experiment hardware (stowed), Ambulatory Data Acquisition System (ADAS), HRF PC or other HRF hardware to complete a specific configuration for a test or procedure.

The WS will require crew intervention and operation typical of current Spacelab, Shuttle Flight Deck, and similar applications involving computers in space. These include, but are not limited to, power cycling and booting, file maintenance, operating system/user interface changes, routine cleaning and health checks, recabling and set-up, and configuration changes such as swapping a hard drive, PC Card, chassis card, or attaching to an external storage device, printer, monitor, or similar equipment.

The WS Computer drawer will be launched and landed in a 4 PU slot of an HRF Rack.

The HRF Flat Screen Display and keyboard will require routine operational handling, stowage, mounting, and movement about the payload area. Nylon hook-and-loop fasteners (commonly called Velcro®) will be placed in appropriate positions to facilitate mounting.

In-flight handling characteristics or restrictions will be developed for crew training purposes.

Cables for the various standard interfaces (Ethernet, RS-422, RS-232, Power, external monitor, printer, HRF PC, HRF Data Acquisition System, etc.) will be provided. Cables for experiment-unique equipment will not be supplied.

The WS Cables, Display and keyboard will be launched and landed in foam in a stowed configuration.

Deliverables consist of the following hardware:

		Quantity	
Part Number	Description	Class I	Class III
SEG46114996-30X	WS Display	3	3
SEG46115669-30X	WS Keyboard	3	3
SEG46114189-30X	WS Computer Drawer	3	3
SEG46115491-30X	WS Display Cable	3	3
SEG46115492-30X	WS Keyboard Cable	3	3

3.1.1.1   HRF Workstation Computer Drawer

The HRF WS Computer Drawer shall use a standard operating system (OS), currently Windows NT, to maintain compatibility with the Portable Computer System (PCS) and other systems. The WS must also be capable of operating software written to operate under Disk Operating System (DOS), either through emulation (or similar techniques with base OS drivers) or by actually running DOS. More information on the software load, OS, user interfaces, drivers, etc. shall be provided in the software documentation for the HRF WS.

The HRF WS Computer Drawer provides a platform for which data interfaces may be established according to the needs and capabilities of the Commercial-Off-the-Shelf (COTS) hardware and software pending conversion into flight certified configuration. This is to say that a standard set of interfaces shall be provided, but additional interfaces and archive media may, and probably will, be specified in the future. The standard electrical and mechanical data interfaces are Ethernet (10Base-T), RS-232C, RS-422, Parallel Port, Floppy drive port, Red, Green, Blue (RGB) video output (left and right eye capable) and input, 32 differential Analog to Digital (A/D), 2 D/A, 16 Digital Input/Output (I/O), National Television Standards Committee (NTSC) Video in/out and sync, Inter-Range Instrumentation Group Standard B (IRIG-B) time interface, Audio in/out, Auxiliary power connector, VGA output, Keyboard output and Peripheral Component Interconnect SCSI-2 interface. Expansion capabilities shall be provided using a built-in Personal Computer Memory Card Industry Association (PCMCIA) Card (PC Card) slot (2 type II or 1 type III) and an internal design that allows removal/replacement of Small Computer System Interface (SCSI) devices of 3.5" format or smaller with no tools in flight.

To perform various routine tasks, software shall be provided that has been tested for compatibility with the hardware configuration, OS and other software components. This shall include, but not be limited to, communication and electronic mail, word processing, spreadsheet, file archiving and manipulation, database management, and common 'office automation' tasks deemed necessary for scientific study. Technically oriented software shall be provided, but specific titles have not been defined. This shall include applications for displaying data, performing analysis and statistical calculations, and building displays for command, control, data acquisition in an automated fashion.

3.1.1.2   HRF WS Keyboard

The HRF WS Keyboard provides cursor control and physical user interface to the HRF WS system. It shall be designed so that it can be mounted on the EXPRESS Rack seat tracks or Velcroed to other locations. The HRF WS Keyboard contains a cursor controller that is similar to the IBM "Trackpoint." It is basically a "miniature" joystick that can be removed and remotely operated separate from the keyboard.

3.1.1.3   HRF Flat Screen Display

The HRF Flat Screen Display is a common hardware item that is shared with the HRF WS, Ultrasound, and possibly other hardware. When attached to the HRF WS, it shall provide display capability using the HRF WS RGB or VGA connector.

3.1.1.4   HRF WS Archive Media

The HRF WS Archive media shall be used to collect data, store data for return to earth, buffer data for downlink, store basic software loads, store Principal Investigator (PI) software/loads and used for software reloads and upgrades. The HRF WS Archive media shall be of two types: a PCMCIA Hard drive and a SCSI hard drive capable of fitting in the standard 3.5" SCSI format.

3.1.1.5   HRF WS Cables

The HRF WS Cables shall provide data and power interface connection between the various parts of the HRF WS components.

3.1.2   Performance Requirements

This HRD uses LS-71001, "Functional Requirements Document (FRD) for the Human Research Facility," to, in part, derive the HRD performance requirements. Section I of the applicability matrix found in Appendix A is a one-to-one mapping of the hardware item functional requirements (functional and technical) to the performance requirements within this HRD (Section 3.1.2). In cases where the FRD requirement has been allocated into a design requirement, that specific HRD requirement paragraph number is indicated. The annotation "DELETION" shall indicate that a functional requirement has not been implemented into the design, and the traceability matrix comment field will indicate the reason. The annotation "ADDITION" shall indicate a functional requirement that is now in the design but was not in the FRD.

3.1.2.1   HRF Workstation Computer Drawer

3.1.2.1.1   The HRF WS Computer Drawer shall have a minimum capability of a 200 MHz Pentium Central Processing Unit.

3.1.2.1.2   The HRF WS Computer Drawer shall have a minimum 256 Kbyte fast Random Access Memory (RAM) secondary (L2) cache and 128 Mbyte RAM main memory.

3.1.2.1.3   The HRF WS Computer Drawer shall have a minimum capability of 8 channels of A/D input (12 bits) and 8 channels Digital to Analog (D/A) output (12 bits),

minimum of a 48 Kilohertz (KHz) maximum sampling rate with the capability to perform audio digital compression and decompression of voice signals.

3.1.2.1.4   The HRF WS Computer Drawer shall have a minimum capability of color stereo video output to a Head Mounted Display (HMD) system.

3.1.2.1.5   The HRF WS Computer Drawer shall have a display support capability of alpha/numeric for console operations. The capability shall meet the interface requirements of the HRF Flat Screen Display and Keyboard and the HRF Personal Computer.

3.1.2.1.6   The HRF WS Computer Drawer shall support a standard QWERTY keyboard input capability via either the HRF Flat Screen Display and keyboard or the HRF Personal Computer. Setup of the display and keyboard shall take less than five minutes.

3.1.2.1.7   The HRF WS Computer Drawer shall have a minimum capability of two RS-422 communication lines capable of 115.2 Kilobits per second (Kbps) communication speed.

3.1.2.1.8   The HRF WS Computer Drawer shall have the capability to allow renewal and replacement of the inflight archival medium, without tools.

3.1.2.1.9   The HRF WS Computer Drawer shall have thermal protection by automatically shutting off the primary power to prevent the front panel touch temperature from reaching a temperature greater than 113 °F (45 °C) and maintain internal component temperature below rated maximum values. The system shall require manual reset before operation after thermal shutoff. The HRF WS Computer Drawer shall be cooled by internal fans.

3.1.2.1.10   The HRF WS Computer Drawer shall use Electromagnetic Interface (EMI)/Radio Frequency Interface filters and gaskets or be chemically filmed per MIL-C-5541, Class 3, for low electrical resistance at all vents, connectors, and drawer joints.

3.1.2.1.11   The HRF WS Computer Drawer archive system shall be capable of archiving 256 Kbps continuously for a minimum of 2 hours while under a computational load and while generating a Graphics load. These test loads shall be configuration managed per LS-71020-1 and will be defined in the test procedures.

3.1.2.1.12   The HRF WS Computer Drawer archive system shall have the capability to be upgraded to an archival media with increased capacity without changing the hardware configuration of the HRF WS Computer Drawer.

3.1.2.1.13   The HRF WS Computer Drawer shall be capable of digitizing/compressing speech for archival and downlink data at a rate as low as 8000 bps.

3.1.2.1.14   The HRF WS Computer Drawer shall have Ethernet interfaces compatible with the EXPRESS Rack system.

3.1.2.1.15   The HRF WS Computer Drawer shall support a printer interface.

3.1.2.1.16   The HRF WS Computer Drawer shall be capable of generating a minimum of 60,000 triangles per second, 24 bit color, 1280 x 1024 resolution.

3.1.2.2   HRF WS Keyboard

3.1.2.2.1   The HRF WS Keyboard shall be a standard QWERTY keyboard. Setup of the keyboard shall take less than five minutes.

3.1.2.2.2   The HRF WS Keyboard will attach to a Human Research Program (HRP) approved mounting bracket.

3.1.2.2.3   The HRF WS Keyboard shall support a cursor controller.

3.1.2.2.4   The HRF WS Keyboard will be stowed for launch and landing and during non-operational use.

3.1.2.2.5   The HRF WS Keyboard shall receive power from the HRF WS Computer Drawer.

3.1.2.3   HRF Flat Screen Display

3.1.2.3.1   The HRF Flat Screen Display will attach to an HRP-approved mounting bracket.

3.1.2.3.2   The HRF Display shall be capable of displaying 1024 x 1280 resolution of 24 bit color.

3.1.2.3.3   The current design will support a 16.1" diagonally measured display.

3.1.2.3.4   The HRF Flat Screen Display will be stowed for launch and landing and during non-operational use.

3.1.2.3.5   The HRF Flat Screen Display shall receive power from the HRF WS Computer Drawer.

3.1.2.4   HRF WS Archive Media

3.1.2.4.1   The HRF WS Archive Media shall be capable of archiving 256 Kbps continuously for a minimum of 2 hours while under a computational load and while generating a Graphics load. These test loads shall be configuration managed per LS-71020-1 and will be defined in the test procedure.

3.1.2.4.2   The HRF WS Archive Media shall have the capability to be upgraded to an archival media with increased capacity without changing the hardware configuration of the HRF WS Computer Drawer.

3.1.2.4.3   The HRF WS Archive media shall be compatible with the HRF WS SCSI Linear Insertion Mechanical Enclosure (LIME) for mechanical mounting purposes and electrical connection.

3.1.2.4.4   The PCMCIA Hard Drive shall have a minimum of 340 Mbytes per card; the SCSI Hard Drive shall have a minimum of 2.1 Gbytes per drive.

3.1.2.5   HRF WS Cables

3.1.2.5.1   Keyboard Cable

                 The HRF WS Keyboard cable shall be used to support keyboard functions.

3.1.2.5.2   Display Cable

                 The HRF Flat Screen Display cable shall be used to support the monitor display.

3.1.3   <u>Limit Load Requirements</u>

                 The HRF WS shall meet the structural requirements of NSTS-1700.7B, "Safety
                 Policy and Requirements for Payloads Using the Space Transportation System,"
                 as stated in Section 6.2.1.4.3 of LS-71000. The HRP is responsible for defining
                 the general limit load for all operational conditions. The Space Station (SS)
                 Load Analysis and Integration Team (AIT) shall approve these load conditions.
                 In addition to the general limit loads, there may be unique loads that a particular
                 hardware design may have. Listed below are these unique loads. Launch and
                 landing loads of the HRF WS Computer Drawer shall meet the requirements as
                 stated in LS-71000, Section 6.2.1.4.3.

3.1.3.1   Launch/Landing Loads

3.1.3.2   Crew Induced Loads

                 The HRF WS shall meet the requirements found in the appropriate section of
                 the HRF PRD. Crew induced loads of the HRF WS Computer Drawer shall
                 meet the requirements as stated in LS-71000, Section 6.2.1.4.5, specifically
                 Table 6.2-5.

3.1.3.3   Pressure Systems

                 N/A

3.1.4   <u>Physical Requirements</u>

3.1.4.1   Mass (Weight)

3.1.4.1.1   HRF Workstation Computer Drawer

                 The weight (mass) of the HRF WS Computer Drawer shall not exceed 80
                 pounds (lbs) (36 kilogram (kg)).

3.1.4.1.2   HRF WS Keyboard

                 The weight (mass) of the HRF WS Keyboard shall not exceed 9 lbs (4 kg).

3.1.4.1.3   HRF Flat Screen Display

                 The weight (mass) of the HRF Flat Screen Display shall not exceed 22 lbs
                 (10 kg), not including attachment brackets.

3.1.4.1.4   HRF WS Cables

The HRF WS cables weight shall not exceed 15 lbs (6.8 kg).

3.1.4.2   Envelope

3.1.4.2.1   HRF Workstation Computer Drawer

The HRF WS Computer Drawer shall fit within the Standard Interface Rack (SIR) envelope for active 4 PU Drawers.

3.1.4.2.2   HRF WS Keyboard

The stowed length, height, and depth of the HRF WS Keyboard shall not exceed 18 in. (46 cm), 10 in. (26 cm), and 2.5 in. (7 cm), respectively.

3.1.4.2.3   HRF Flat Screen Display

The stowed length, height, and depth of the HRF Flat Screen Display shall not exceed 18 in. (45-72 cm), 15 in. (38.1 cm), and 4.75 in. (12 cm), respectively.

3.1.4.2.4   HRF WS Archive Media

The stowed length, height, and depth of the HRF WS Archive media, PCMCIA Hard Drive type, shall not exceed 4 in. (10 cm), 2.5 in. (7 cm), and 0.5 in. (2 cm), respectively.

The stowed length, height, and depth of the HRF WS Archive media, SCSI Hard Drive type shall not exceed 1.5 in. (4 cm), 6 in. (16 cm), and 5 in. (8 cm), respectively.

3.1.4.2.5   HRF WS Cables

The HRF WS Cable volume shall not exceed 75 in^3 per cable.

3.1.4.3   Center of Gravity

The center of gravity of the HRF WS Computer Drawer shall be measured and documented. None of the stowed items will be measured.

3.1.5   Interface

3.1.5.1   Mechanical Interface Requirements

The structural and mechanical design of the HRF WS Computer Drawer shall be compatible with the applicable requirements of LS-71000, Sections 6.2.1.1 and 6.2.1.2.

3.1.5.2   Electrical Interface Requirements

The electrical design of the HRF WS shall be compatible with the applicable requirements of Section 6.2.2 of the HRF PRD. The following sections delineate the electrical interface requirements for the end item of this HRD.

3.1.5.2.1   HRF Workstation to Rack

HRF PRD Section 6.2.2.2 Electrical Power Interface is applicable to the HRF WS.

3.1.5.2.2   HRF Workstation to Other Payloads

HRF WS to other payloads interfaces shall be covered in those other payload's Interface Control Documents (ICD)s. HRF WS development personnel shall produce a HRF WS IDD that describes the generic HRF WS electrical interfaces available to the other payloads. In general, there are electrical power interfaces at the front panel for 28 Volts Direct Current (Vdc) from the EXPRESS Rack.

3.1.5.3   Command and Data Handling Interface Requirements

3.1.5.3.1   HRF Workstation to Rack

The HRF WS Computer Drawer Command and Data Handling (C&DH) Interface requirements shall meet the applicable requirements of Section 6.2.3 of the HRF PRD.

3.1.5.3.2   HRF Workstation to Other Payloads

HRF WS interfaces to other payloads shall be covered in the ICDs for those payloads. HRF WS development personnel shall produce a HRF WS IDD that describes the generic HRF WS command and data interfaces available to the other payloads. In general, the following are interfaces available to the other HRF payloads for use:

a. The HRF WS Computer Drawer shall have an RGB interface with two channels out and one channel in to the drawer.

b. The HRF WS Computer Drawer shall have an Analog-to-Digital interface.

c. The HRF WS Computer Drawer shall have a Digital-to-Analog interface.

d. The HRF WS Computer Drawer shall have a Digital Input/Output interface.

e. The HRF WS Computer Drawer shall have a parallel interface.

f. The HRF WS Computer Drawer shall have an NTSC/RS-170 video interface for video in, video out and video sync.

g. The HRF WS Computer Drawer shall have an IRIG-B interface.

h. The HRF WS Computer Drawer shall have an audio interface for signals in and out.

i. The HRF WS Computer Drawer shall have three serial interfaces.

j. The HRF WS Computer Drawer shall have a VGA and keyboard interface.

k. The HRF WS Computer Drawer shall have an Ethernet interface.

l. The HRF WS Computer Drawer shall have a SCSI interface.

3.1.5.4	Audio/Video Interface Requirements

For those HRF devices that require audio/visual data transfer, the requirements of Section 6.2.4 of the HRF PRD shall apply. The following sections describe the requirements that are applicable for this hardware's design.

3.1.5.4.1	HRF Workstation to Rack

For HRF WS Computer drawer, the video requirements of Section 6.2.4.1.2 of the HRF PRD shall apply.

3.1.5.4.2	HRF Workstation to Other Payloads

Audio/video interfaces between the HRF WS and other payloads shall be covered in the ICDs for those payloads. HRF WS development personnel shall produce a HRF WS IDD that describes the generic HRF WS audio/visual interfaces available to the other payloads.

3.1.5.5	Thermal Control Interface Requirements

For those HRF devices that require the use of the rack supplied thermal control system, the requirements of Section 6.2.5 of the HRF PRD shall apply.

3.1.5.5.1	General Requirements

3.1.5.5.2	HRF Rack Common Fan

The HRF WS shall incorporate the HRF Rack Common Fan (P/N SEG46116060-701) into its design per TBD.

3.1.5.5.2.1	HRF Rack Common Fan Intravehicular Activity (IVA) Replacement

The HRF Rack Common Fan shall be IVA replaceable.

3.1.5.5.2.2	HRF Rack Common Fan Vibration/Acoustic Isolation

The HRF Rack Common Fan shall be vibration/acoustic isolated from structure/chassis.

3.1.5.6	Waste Gas Vent and Vacuum Interface Requirements

N/A

3.1.5.7	Nitrogen Interface Requirements

N/A

3.1.6	Software Design Requirements

This section contains the software requirements for the Computer Software Configuration Items (CSCI) associated with the HRF WS. Each software requirement shall be traceable back to a functional requirement in this HRD or in the FRD. The requirements traceability matrix is shown in Tables 3.1.6-1 and 3.1.6-2. The requirements allocation matrix is shown in Tables 3.1.6-3 and

3.1.6-4. The verification process for each CSCI is listed in the Certification
Matrix (Appendix B). The type, category, and operational modes required shall
be identified for each CSCI (see Table 3.1.6-5). All activities involving
software development and software acquisition shall be performed in
accordance with the "Software Development Plan (SDP) for the Human
Research Facility," (LS-71020). Hardware units certification/verification shall
be accomplished with only OS and test CSCI.

TABLE 3.1.6-1. HRD REQUIREMENTS TRACEABILITY MATRIX

HRD Requirement Identifier	CSCI Requirements
3.1.2.1.1	3.1.6.2
3.1.2.1.2	3.1.6.2
3.1.2.1.3	3.1.6.2, 3.1.6.7
3.1.2.1.4	3.1.6.2, 3.1.6.7
3.1.2.1.5	3.1.6.2
3.1.2.1.6	3.1.6.2
3.1.2.1.7	3.1.6.2
3.1.2.1.8	3.1.6.2
3.1.2.1.9	N/A
3.1.2.1.10	N/A
3.1.2.1.11	3.1.6.9
3.1.2.1.12	3.1.6.2
3.1.2.1.13	3.1.6.7
3.1.2.1.14	3.1.6.9
3.1.2.1.15	3.1.6.2
3.1.2.1.16	3.1.6.2
3.1.2.2.1	3.1.6.2
3.1.2.2.2	N/A
3.1.2.2.3	3.1.6.2
3.1.2.2.4	N/A
3.1.2.2.5	N/A
3.1.2.3.1	N/A
3.1.2.3.2	3.1.6.2
3.1.2.3.3	3.1.6.2
3.1.2.3.4	N/A
3.1.2.3.5	N/A
3.1.2.4.1	3.1.6.2
3.1.2.4.2	3.1.6.2
3.1.2.4.3	3.1.6.2
3.1.2.4.4	3.1.6.2
3.1.2.5	N/A

TABLE 3.1.6-2. FRD REQUIREMENTS TRACEABILITY MATRIX

FRD Requirement Identifier	CSCI Requirements
24.2.1	3.1.6.2
24.2.2	3.1.6.9, 3.1.6.10
24.2.3	3.1.6.2
24.2.4	3.1.6.2
24.2.5	N/A
24.2.6	3.1.6.2, 3.1.6.8, 3.1.6.3
24.2.7	3.1.6.7
24.2.8	N/A
24.2.9	3.1.6.3
24.2.10	3.1.6.8, 3.1.6.7
24.2.11	3.1.6.5
24.2.12	3.1.6.2
24.2.13	3.1.6.2
24.2.14	3.1.6.2
24.2.15	3.1.6.8
24.2.16	3.1.6.8
24.2.17	3.1.6.2
24.2.18	3.1.6.2, 3.1.6.9, 3.1.6.10
24.2.19	3.1.6.2
24.2.20	3.1.6.7
24.2.21	3.1.6.2
24.2.22	3.1.6.2
24.2.23	3.1.6.2
24.2.24	3.1.6.9, 3.1.6.10
24.2.25	3.1.6.2
24.3.1	N/A
24.3.2	3.1.6.2
24.3.3	N/A
24.3.4	N/A
24.3.5	N/A
24.3.6	3.1.6.2
24.3.7	3.1.6.2, 3.1.6.8
24.3.8	3.1.6.2
24.3.9	3.1.6.2
24.3.10	3.1.6.2
24.3.11	3.1.6.7, 3.1.6.3
24.3.12	N/A
24.4.1	N/A

TABLE 3.1.6-3. HRD REQUIREMENTS ALLOCATION MATRIX

CSCI Requirements	HRD Requirement Identifier
3.1.6.2	3.1.2.1.1, 3.1.2.1.2, 3.1.2.1.3, 3.1.2.1.4, 3.1.2.1.5, 3.1.2.1.6, 3.1.2.1.7, 3.1.2.1.8, 3.1.2.1.12, 3.1.2.1.15, 3.1.2.1.16, 3.1.2.2.1, 3.1.2.2.3, 3.1.2.3.2, 3.1.2.3.3, 3.1.2.4.1, 3.1.2.4.2, 3.1.2.4.3, 3.1.2.4.4
3.1.6.3	N/A
3.1.6.4	N/A
3.1.6.5	N/A
3.1.6.6	N/A
3.1.6.7	3.1.2.1.3, 3.1.2.1.4
3.1.6.8	N/A
3.1.6.9	3.1.2.1.11, 3.1.2.1.14
3.1.6.10	N/A

TABLE 3.1.6-4. FRD REQUIREMENTS ALLOCATION MATRIX

CSCI Requirements	FRD Requirement Identifier
3.1.6.2	24.2.1, 24.2.3, 24.2.4, 24.2.6, 24.2.12, 24.2.13, 24.2.14, 24.2.17, 24.2.18, 24.2.19, 24.2.21, 24.2.22, 24.2.23, 24.2.25, 24.3.2, 24.3.6, 24.3.7, 24.3.8, 24.3.9, 24.3.10
3.1.6.3	24.2.6, 24.2.9, 24.3.11
3.1.6.4	N/A
3.1.6.5	24.2.11
3.1.6.6	N/A
3.1.6.7	24.2.7, 24.2.10, 24.2.20, 24.3.11
3.1.6.8	24.2.6, 24.2.10, 24.2.15, 24.2.16, 24.3.7
3.1.6.9	24.2.2, 24.2.3, 24.2.24
3.1.6.10	24.2.2, 24.2.18, 24.2.24

TABLE 3.1.6-5. WORKSTATION CSCI TYPES, CATEGORIES, AND MODES

CSCI 3.1.6.1.1	Types of Software 3.1.6.1.3				Software Categories 3.1.6.1.4					Modes 3.1.6.1.5		
	FLT .1	GRND .2	TEST & SIM .3	TRNG .4	CUSTB UTIL. .1	MOTS	MOD GFS .3	COTS .4	GFS .5	NORMAL .1	S/W UPGRADES .2	DIAGS .3
OS 3.1.6.2	X	X	X	X		X		X		X	X	X
User Interface 3.1.6.3	X	X	X	X	X	X	X	X	X	X	X	X
Test 3.1.6.4	X	X	X	X	X	X	X	X		X		X
Training 3.1.6.5		X	X	X	X	X	X	X	X	X	X	X
Office 3.1.6.6	X		X	X	X	X	X	X	X	X		X
Lab 3.1.6.7	X		X	X	X	X	X	X	X	X		X
Eng. 3.1.6.8	X		X	X	X	X	X	X	X	X		X
Flight Support 3.1.6.9	X				X		X	X	X	X	X	X
Ground 3.1.6.10		X		X	X	X	X	X	X	X		X

3.1.6   Definitions

3.1.6.1.1   Computer Software Configuration Item

A CSCI is an aggregation of software or firmware which satisfies an end use function and is designated for configuration management.

3.1.6.1.1.1   Operating System CSCI

The OS CSCI provides resource management and a low level interface between the hardware and the users.

3.1.6.1.1.2   Flight Support Software CSCI

Flight support software CSCI is used to support flight or increment-specific requirements.

3.1.6.1.1.3   Ground Software CSCI

Ground software CSCI is specifically used to support ground operations with flight operations and ground simulations.

3.1.6.1.1.4	Training Software CSCI

Training software CSCI is specifically used to provide familiarity with software applications and hardware to users, and supports proper hardware utilization.

3.1.6.1.1.5	Office Software CSCI

Office software CSCI is used to support basic business activities.

3.1.6.1.1.6	Lab Software CSCI

Lab software CSCI is used to support data analysis, data acquisition and visualization.

3.1.6.1.1.7	Engineering Software CSCI

Engineering software CSCI is used to support Computer Aided design/analysis functions.

3.1.6.1.1.8	User Interface CSCI

User interface software provides the generic human computer interface to hardware and other software.

3.1.6.1.1.9	Test CSCI

The test CSCI will be used for test and verification of the hardware.

3.1.6.1.2	Software Requirements Definitions

Capability Requirements

This paragraph specifies the generic capabilities of the CSCI.

External Interface Requirements

This paragraph specifies the requirements for any interface outside the software CSCI.

Internal Interface Requirements

This paragraph defines the requirements for any interface within the software CSCI.

Internal Data Requirements

This paragraph specifies the CSCI requirements, if any, imposed on data passed internal to CSCI.

Adaptation Requirements

This paragraph specifies the CSCI requirements, if any, concerning installation-dependent data to be provided by the CSCI, such as ISS dependent data,

operational parameters that may vary according to operational needs such as downlink stream definition.

Safety Requirements

This paragraph specifies the CSCI requirements imposed on the CSCI due to the CSCI's ability to endanger the crew or the vehicle.

Security Requirements

This paragraph specifies the CSCI requirements, if any, concerned with maintaining security and privacy.

Environment Requirements

This paragraph specifies the CSCI requirements, if any, regarding the environment in which the CSCI must operate; e.g., operate under Windows NT, x86 Processor, etc.

Software Quality Factors

This paragraph specifies the CSCI requirements, if any, concerned with software quality factors identified in the contract or derived from a higher level specification.

Design and Implementation Constraints

This paragraph specifies the CSCI requirements, if any, that constrain the design and implementation of the CSCI; e.g., guidelines such as the SDP.

Other Requirements

This paragraph specifies the CSCI requirements, if any, not covered in previous paragraphs.

Precedence and Criticality of Requirements

This paragraph specifies, if applicable, the order of precedence, criticality, or assigned weights indicating the relative importance of the requirements in this specification.

3.1.6.1.3   Types of Software

Flight Software (FLT)

Flight software is the software that will be installed on the flight articles and shall be used on-orbit.

Ground Software (GRND)

Ground software is the software that interfaces with flight hardware and must be developed and verified to the same standards as the flight software. Typically this software will interface with flight software during flight operations.

<u>Test and Simulation Software</u>

Test and simulation software will provide the environment for the integration and verification of the HRF flight software and avionics from software development through integration. This will involve the test environment with end-item and segment simulations; environmental simulations which represent the HRF on-orbit environment and dynamics and sensor/effector simulations. Some simulations will be reused in verification activities at multiple facilities (i.e., End-Item, Stage, and Launch Package).

<u>Training Software</u>

Training software is the software that will be used to support training efforts. Flight software that has been modified for training use will be downgraded from flight software status.

Training versions of software must be clearly designated as ground use only. Markings can appear on the media on which the software is stored or displayed on a monitor when the software is loaded.

3.1.6.1.4   Software Categories

<u>Custom-Build Software</u>

Custom-build software is software written by HRF personnel based on requirements defined in a requirements document to meet specifications in the FRD or PRD.

<u>Modified Commercial-Off-the-Shelf Software</u>

Modified Commercial-Off-the-Shelf (MOTS) software is COTS software that must be customized for HRF use. All modified portions of COTS software must comply with the same development and documentation standards and procedures as custom-build software. Supplier documentation can be included in HRF documents by reference.

<u>Modified Government Furnished Software</u>

Modified Government Furnished Software (GFS) is government furnished software that must be customized for HRF use. All modified portions of the GFS software must comply with the same development and documentation standards and procedures as custom-build software. Supplier documentation can be included in HRF documents by reference.

<u>Commercial-Off-the-Shelf Software</u>

COTS software is commercially available software and is a low-risk, low-cost alternative to developing new software.

Provisions must be made with the COTS vendor to provide support for this software over the life of the HRF program. This support should be in a form of a renewable service contract or an escrow account containing the source code, tools required to build an executable and any available design documentation.

<u>Government Furnished Software</u>

GFS is software provided by NASA for use on HRF. This software may have been developed by HRF personnel, but not under the HRF project. Experiment-unique software not generated through HRF task orders will be treated as GFS.

3.1.6.1.5   Required Modes

<u>Normal Mode</u>

The CSCI shall perform in accordance with requirements defined, with the exception of those requirements defined for other modes. All CSCIs will be required to operate under normal mode.

<u>Software Upgrades Mode</u>

The CSCI shall support upgrades of its software modules and other CSCIs.

<u>Diagnostic Mode</u>

The CSCI shall support malfunction detection, trouble shooting, checkout procedures, and health and status. For COTS items no additional diagnostic software is required.

3.1.6.2   Operating System

The OS provides resource management and the low level interface between hardware and users.

3.1.6.2.1   CSCI Functional and Performance Requirements

3.1.6.2.1.1   The OS used for HRF workstation shall operate on hardware identified in Section 3.0 of the HRF Workstation HRD.

3.1.6.2.1.1.2   The OS shall be able to support multi-user, multi-threaded applications.

3.1.6.2.1.1.3   The OS shall be capable of providing resource management including Fault detection and recovery, and communication.

3.1.6.2.1.1.4   The OS shall support the graceful shutdown of the system.

3.1.6.2.1.1.5   Software Upgrades Mode

The OS used for HRF WS shall support the capability to be upgraded.

3.1.6.2.1.1.6   Diagnostic Mode

The OS used for HRF WS shall support malfunction detection, trouble shooting and checkout procedures.

3.1.6.2.2	CSCI External Interface Requirements
3.1.6.2.2.1	The OS shall support External I/O interfaces (e.g., disk drive, keyboard, printers, serial port, joystick, etc.) and Internal I/O interfaces (e.g., Memory management, Bus management, etc.).
3.1.6.2.2.2	The OS shall provide basic driver support for common hardware.
3.1.6.2.3	CSCI Internal Interface Requirements
	The internal interface requirements are defined by the vendor.
3.1.6.2.4	CSCI Internal Data Requirements
	The internal data requirements are defined by the vendor.
3.1.6.2.5	CSCI Adaptation Requirements
	Any installation-dependent data shall be defined in the Verification Description Document (VDD) or in vendor documentation.
3.1.6.2.6	CSCI Safety Requirements
	N/A
3.1.6.2.7	CSCI Data Privacy Requirements
	The OS shall provide individual log-in capability and data privacy.
3.1.6.2.8	CSCI Environment Requirements
3.1.6.2.8.1	Any installation-dependent data shall be defined by the CSCI, such as ISS dependent data. Operational parameters may vary according to operational needs, such as downlink stream definition.
3.1.6.2.8.2	The OS shall be configurable to match the hardware platform. (Environment requirements are as defined in hardware drawings.)
3.1.6.2.9	CSCI Software Quality Factors
	Software quality factors are defined by the OS vendor.
3.1.6.2.10	CSCI Design and Implementation Constraints
	N/A
3.1.6.2.11	Precedence and Criticality of Requirements
	All requirements shall be considered to be equally weighted.

3.1.6.3   User Interface

                 This software shall provide a generic human interface to hardware and software.
                 A User interface mainly consists of graphical interface that allows users to
                 interact with all applications.

3.1.6.3.1   CSCI Functional and Performance Requirements

3.1.6.3.1.1   The HRF workstation user interface software shall provide user interfaces for
                 crew, ground support and development personnel.

3.1.6.3.1.2   The HRF workstation user interface software shall be able to verify health and
                 status of the HRF workstation hardware and software (HRF workstation and
                 other devices).

3.1.6.3.1.3   Software Upgrade Mode

                 The HRF WS user interface software shall have the capability to support
                 software upgrades.

3.1.6.3.1.4   Diagnostic Mode

                 The HRF WS user interface software shall support malfunction detection,
                 trouble shooting and checkout procedures.

3.1.6.3.2   CSCI External Interface Requirements

3.1.6.3.2.1   The HRF workstation user interface software shall interface with the following:
                 I/O peripheral devices, HRF hardware and software, ISS communication, ISS
                 EXPRESS, data archive, simulations and test.

3.1.6.3.2.2   The HRF workstation user interface software shall be able to verify health and
                 status of HRF experiment and ISS hardware and software as defined in the
                 Software Design Document (SDD).

3.1.6.3.3   CSCI Internal Interface Requirements

                 Internal interface requirements for HRF WS user interface software shall be
                 defined in an increment-specific SDD and VDD or shall be defined in vendor
                 documentation.

3.1.6.3.4   CSCI Internal Data Requirements

                 Internal data requirements shall be defined in the SDD or in vendor document.

3.1.6.3.5   CSCI Adaptation Requirements

                 Any installation-dependent data shall be defined in an increment-specific SDD
                 and VDD.

3.1.6.3.6   CSCI Safety Requirements

                 N/A

3.1.6.3.7   CSCI Data Privacy Requirements

There currently are no CSCI Data Privacy requirements. Future requirements, if any, shall be defined in the SDD.

3.1.6.3.8   CSCI Environment Requirements

3.1.6.3.8.1   HRF workstation user interface software shall be configurable to match hardware platform, test hardware and software and data.

3.1.6.3.8.2   HRF workstation user interface software shall be required to operate within the environment defined in Section 3.0.

3.1.6.3.9   CSCI Software Quality Factors

There are no software quality factors defined at this time. Software quality factors defined in the future shall be documented in an increment-specific SDD.

3.1.6.3.10   CSCI Design and Implementation Constraints

Currently there are no design and implementation constraints for User Interface. Future design and implementation constraints shall be documented in an increment-specific SDD.

3.1.6.3.11   Precedence and Criticality of Requirements

All requirements shall be considered to be equally weighted.

3.1.6.4   Test Software

Software specifically used to support tests during acceptance, qualification and troubleshooting tests.

3.1.6.4.1   CSCI Functional and Performance Requirements

3.1.6.4.1.1   The HRF workstation test software shall provide the capability to detect problems and failures in the HRF WS.

3.1.6.4.1.2   The HRF workstation test software shall be capable of testing the hardware components, where applicable, and indicate that component is not functioning nominally.

3.1.6.4.1.3   The HRF workstation ground software shall support qualification testing, acceptance testing and troubleshooting.

3.1.6.4.1.5   Diagnostic Mode

HRF WS test software shall support malfunction detection, trouble shooting and checkout procedures.

3.1.6.4.2   CSCI External Interface Requirements

3.1.6.4.2.1   The HRF workstation test software shall interface with the following:

>   HRF hardware and software
>   Ground Support Equipment (GSE) hardware and software
>   SS communication
>   ISS EXPRESS
>   Data archive
>   Simulations and test

Details of these interfaces shall be defined in the SDD.

3.1.6.4.3   CSCI Internal Interface Requirements

Internal interface requirements shall be defined in an increment-specific SDD.

3.1.6.4.4   CSCI Internal Data Requirements

Internal data requirements shall be defined in an increment-specific SDD.

3.1.6.4.5   CSCI Adaptation Requirements

Any installation-dependent data shall be defined in an increment-specific VDD.

3.1.6.4.6   CSCI Safety Requirements

N/A

3.1.6.4.7   CSCI Data Privacy Requirements

Security requirements shall be defined in the SDD.

3.1.6.4.8   CSCI Environment Requirements

3.1.6.4.8.1   HRF workstation test software shall be configurable to match the hardware platform, test hardware and software, and data.

3.1.6.4.8.2   HRF workstation test software shall be required to operate within environment defined in Section 3.1.6.2.

3.1.6.4.9   CSCI Software Quality Factors

There are no software quality factors defined at this time. Software quality factors defined in the future shall be documented in an increment-specific SDD.

3.1.6.4.10   CSCI Design and Implementation Constraints

There are currently no design and implementation constraints for test software. Future design and implementation constraints shall be documented in an increment-specific SDD.

3.1.6.4.11   Precedence and Criticality of Requirements

All requirements shall be considered to be equally weighted.

3.1.6.5   Training Software

Training software is specifically used to provide familiarity with software application and hardware to users and to support proper HRF WS utilization.

3.1.6.5.1   CSCI Functional and Performance Requirements

3.1.6.5.1.1   HRF workstation training software shall provide an introduction to HRF workstation software, an HRF ISS express rack, and experiment hardware and software. Details shall be defined in the SDD.

3.1.6.5.1.2   HRF workstation training software shall provide methods to assure proper utilization of HRF hardware, software, HRF ISS EXPRESS Rack, and experiment hardware and software. Details shall be defined in the SDD.

3.1.6.5.1.3   The HRF workstation training software shall be able to verify condition of health and status of HRF workstation hardware and software (HRF workstation and other devices).

3.1.6.5.1.4   Software Upgrades Mode

HRF WS training software shall have the capability to support software upgrades.

3.1.6.5.1.5   Diagnostic Mode

HRF WS training software shall support malfunction detection, trouble shooting and checkout procedures.

3.1.6.5.2   CSCI External Interface Requirements

3.1.6.5.2.1   HRF workstation training software shall interface with the following:

3.1.6.5.2.2   I/O peripheral devices, HRF hardware and software, ISS communication, ISS EXPRESS, data archive, simulations and test hardware and software.

3.1.6.5.2.3   The HRF workstation training software shall be able to verify the health and status of HRF experiment and ISS hardware and software. Details shall be defined in the SDD.

3.1.6.5.3   CSCI Internal Interface Requirements

Internal interface requirements for HRF WS training software shall be defined in an increment-specific SDD.

3.1.6.5.4   CSCI Internal Data Requirements

Internal data requirements shall be defined in an increment-specific SDD.

3.1.6.5.5	CSCI Adaptation Requirements

Any installation-dependent data shall be defined in an increment-specific VDD.

3.1.6.5.6	CSCI Safety Requirements

N/A

3.1.6.5.7	CSCI Data Privacy Requirements

Security requirements shall be defined in the SDD.

3.1.6.5.8	CSCI Environment Requirements

3.1.6.5.8.1	HRF workstation training software shall be configurable to match the hardware platform, test hardware, and test software and data.

3.1.6.5.8.2	HRF workstation training software shall be required to operate within environment defined in Section 3.1.6.2.

3.1.6.5.9	CSCI Software Quality Factors

There are no software quality factors defined at this time. Software quality factors defined in the future shall be documented in an increment-specific SDD.

3.1.6.5.10	CSCI Design and Implementation Constraints

There are no design and implementation constraints defined at this time. Future design and implementation constraints shall be documented in an increment-specific SDD.

3.1.6.5.11	Precedence and Criticality of Requirements

All requirements shall be considered to be equally weighted.

3.1.6.6	Office Software

Office software is used to support basic business activity; e.g., word processor, spreadsheets, Spellchecker, Email, Scheduling, presentation etc.

3.1.6.6.1.1	CSCI Functional and Performance Requirements

HRF WS office software shall provide common professional computer support functions.

3.1.6.6.1.2	Diagnostic Mode

HRF WS office software shall support malfunction detection, trouble shooting and checkout procedures. Details shall be defined in the SDD.

3.1.6.6.2	CSCI External Interface Requirements

HRF WS office software external interface requirements are defined by the vendor or shall be defined in the SDD as needed.

3.1.6.6.3   CSCI Internal Interface Requirements

HRF WS office software internal interface requirements are defined by the vendor or shall be defined in the SDD as needed.

3.1.6.6.4   CSCI Internal Data Requirements

Internal data requirements are defined by the vendor or shall be defined in the SDD as needed.

3.1.6.6.5   CSCI Adaptation Requirements

Any installation-dependent data shall be defined in an increment-specific VDD or in vendor documentation.

3.1.6.6.6   CSCI Safety Requirements

N/A

3.1.6.6.7   CSCI Data Privacy Requirements

HRF WS office software shall provide virus detection capability. Additional security requirements shall be defined in the SDD.

3.1.6.6.8   CSCI Environment Requirements

3.1.6.6.8.1   HRF workstation office software shall be configurable to match hardware platform, test hardware and test software and data.

3.1.6.6.8.2   HRF workstation office software shall be required to operate within the OS environment defined in Section 3.0.

3.1.6.6.9   CSCI Software Quality Factors

There are no software quality factors defined at this time. Software quality factors defined in the future shall be documented in an increment-specific SDD.

3.1.6.6.10   CSCI Design and Implementation Constraints

There are no design and implementation constraints defined at this time. Future design and implementation constraints shall be documented in an increment-specific SDD.

3.1.6.6.11   Precedence and Criticality of Requirements

All requirements shall be considered to be equally weighted.

3.1.6.7   Lab Software

Software shall be used to support data analysis, data acquisition and visualization of data; e.g., object oriented designing tools, digital signal processor tools, and data set visualization software.

3.1.6.7.1	CSCI Functional and Performance Requirements
3.1.6.7.1.1	The HRF workstation lab software shall provide capability to add voice recognition functions.
3.1.6.7.1.2	HRF workstation lab software shall provide data manipulation capability.
3.1.6.7.1.3	HRF workstation lab software shall provide data processing and data presentation capability.
3.1.6.7.1.4	Diagnostic Mode.
	HRF WS lab software shall support malfunction detection, trouble shooting and checkout procedures.
3.1.6.7.2	CSCI External Interface Requirements
3.1.6.7.2.1	The HRF workstation lab software shall have the capability to convert and synchronize multiple analog signals to digital and digital to analog to create virtual instruments.
3.1.6.7.2.2	The HRF workstation lab software shall have capability to accept and utilize graphics software.
3.1.6.7.2.3	The HRF workstation lab software shall provide the interface to voice input and sound output.
3.1.6.7.3	CSCI Internal Interface Requirements
	Internal interface requirements for HRF WS lab software shall be defined in an increment-specific SDD and VDD or defined in vendor documentation.
3.1.6.7.4	CSCI Internal Data Requirements
	Internal data requirements shall be defined in an increment-specific SDD or in vendor documentation.
3.1.6.7.5	CSCI Adaptation Requirements
	Any installation-dependent data shall be defined in an increment-specific VDD.
3.1.6.7.6	CSCI Safety Requirements
	N/A
3.1.6.7.7	CSCI Data Privacy Requirements
	There are no data privacy requirements at this time. Future requirements, if any, shall be defined in the SDD.
3.1.6.7.8	CSCI Environment Requirements
3.1.6.7.8.1	HRF workstation lab software shall be configurable to match hardware platform, test hardware, software and data.

| 3.1.6.7.8.2 | HRF workstation lab software shall be required to operate within the OS environment defined in Section 3.1.6.2 of this HRD. |

3.1.6.7.9   CSCI Software Quality Factors

There are no software quality factors defined at this time. Software quality factors defined in the future shall be documented in an increment-specific SDD.

3.1.6.7.10   CSCI Design and Implementation Constraints

There are no design and implementation constraints defined at this time. Future design and implementation constraints shall be documented in an increment-specific SDD.

3.1.6.7.11   Precedence and Criticality of Requirements

All requirements shall be considered to be equally weighted.

3.1.6.8   Engineering Software

Engineering software is used to support engineering functions; e.g., computer aided drafting, computer aided software engineering, computer aided engineering, virtual reality application programmer's interface, etc.

3.1.6.8.1   CSCI Functional and Performance Requirements

3.1.6.8.1.1   HRF workstation engineering software shall support three dimensional modeling/animation.

3.1.6.8.1.2   HRF workstation engineering software shall provide computational capability for experiment data.

3.1.6.8.1.3   HRF workstation engineering software shall provide drafting and designing support capability.

3.1.6.8.1.4   Diagnostic Mode

HRF WS engineering software shall support malfunction detection, trouble shooting and checkout procedures.

3.1.6.8.2   CSCI External Interface Requirements

HRF WS engineering software shall interface with following: I/O peripheral devices, HRF hardware and software, ISS communication, ISS EXPRESS, data archive, simulations and test.

3.1.6.8.3   CSCI Internal Interface Requirements

Internal Interface Requirements for HRF WS engineering software shall be defined in an increment-specific SDD and VDD or shall be defined in vendor documentation.

3.1.6.8.4	CSCI Internal Data Requirements
	Internal data requirements shall be defined in the SDD or in vendor documentation.
3.1.6.8.5	CSCI Adaptation Requirements
	Any installation-dependent data shall be defined in an increment-specific VDD or in vendor documentation.
3.1.6.8.6	CSCI Safety Requirements
	N/A
3.1.6.8.7	CSCI Data Privacy Requirements
	There are no data privacy requirements. Future requirements, if any, shall be defined in the SDD.
3.1.6.8.8	CSCI Environment Requirements
3.1.6.8.8.1	HRF workstation engineering software shall be configurable to match hardware platform, test hardware, test software and data.
3.1.6.8.8.2	HRF workstation engineering software shall be required to operate within the OS environment defined in Section 3.1.6.3.
3.1.6.8.9	CSCI Software Quality Factors
	There are no software quality factors defined at this time. Software quality factors defined in the future shall be documented in an increment-specific SDD.
3.1.6.8.10	CSCI Design and Implementation Constraints
	There are no design and implementation constraints defined at this time. Future design and implementation constraints shall be documented in an increment-specific SDD.
3.1.6.8.11	Precedence and Criticality of Requirements
	All requirements shall be considered to be equally weighted.
3.1.6.9	Flight Support Software
	Flight support software is used to support flight- or increment-specific requirements.
3.1.6.9.1	CSCI Functional and Performance Requirements
3.1.6.9.1.1	HRF workstation flight support software shall provide the framework for experiment software execution as approved by the HRP CCB.
3.1.6.9.1.2	The HRF workstation flight support software shall be able to verify the health and status of the HRF workstation hardware and software (HRF workstation

and other devices). Details of the health and status indicators/information shall be defined in the SDD.

3.1.6.9.1.3   Software Upgrades

HRF WS flight support software shall support software upgrades.

3.1.6.9.1.4   Diagnostic Mode

HRF WS flight support software shall support malfunction detection, trouble shooting and checkout procedures.

Other capability requirements shall be defined in the SDD.

3.1.6.9.2   CSCI External Interface Requirements

3.1.6.9.2.1   The workstation flight support software shall process uplink commands from ground/crew through the RIC.

3.1.6.9.2.2   The HRF workstation flight support software shall provide experiment data to ground personnel through the RIC.

3.1.6.9.2.3   HRF workstation flight support software shall provide real-time data downlink via the RIC.

3.1.6.9.2.4   HRF workstation flight support software shall provide the capability to archive and to downlink voice data.

3.1.6.9.2.5   The HRF workstation flight support software shall provide increment-unique communication capability for experiments.

3.1.6.9.2.6   The HRF workstation flight support software shall provide increment-unique data transfer between experiments.

3.1.6.9.2.7   The HRF workstation flight support software shall provide increment-unique acquisition capability for experiment data.

3.1.6.9.2.8   The HRF workstation flight support software shall provide increment-unique stored data to systems upon request.

3.1.6.9.2.9   The HRF workstation flight support software shall provide increment-unique file management capability not included in the OS.

3.1.6.9.2.10   The HRF workstation flight support software shall be capable of checking the health and status of all interfaces and providing interface diagnostic requirements support. Details of this support shall be defined in the SDD.

3.1.6.9.3   CSCI Internal Interface Requirements

Internal interface requirements shall be defined in the SDD.

3.1.6.9.4   CSCI Internal Data Requirements

Internal data requirements shall be defined in the SDD.

3.1.6.9.5	CSCI Adaptation Requirements

Any installation-dependent data shall be defined in a VDD.

3.1.6.9.6	CSCI Safety Requirements

N/A

3.1.6.9.7	CSCI Data Privacy Requirements

HRF WS flight support software shall provide increment-unique data privacy and data protection capabilities.

3.1.6.9.8	CSCI Environment Requirements

3.1.6.9.8.1	HRF workstation flight support software shall be compatible with the HRF WS hardware platform.

3.1.6.9.8.1	HRF workstation flight support software shall be required to operate within the environment defined in Section 3.0.

3.1.6.9.9	CSCI Software Quality Factors

There are no software quality factors defined at this time. Software quality factors defined in the future shall be documented in an increment-specific SDD.

3.1.6.9.10	CSCI Design and Implementation Constraints

These constraints shall be defined in an increment-specific SDD and VDD.

Communication protocols for downlink and uplink shall adhere to ISS and EXPRESS protocols.

3.1.6.9.11	Precedence and Criticality of Requirements

All requirements shall be considered to be equally weighted.

3.1.6.10	Ground Software

Ground software is used to support ground operations with flight operations and ground simulations.

3.1.6.10.1	CSCI Functional and Performance Requirements

3.1.6.10.1.1	The HRF workstation ground software shall provide data analysis and display software.

3.1.6.10.1.2	The HRF workstation ground software shall be capable of handling ground communications, commands, data receiving/transmission, and data analysis.

3.1.6.10.1.3	The HRF workstation ground software shall support ground simulations.

3.1.6.10.1.4   The HRF workstation ground software shall be able to verify conditions of health and status of HRF workstation hardware and software (HRF workstation and other devices).

3.1.6.10.1.5   Diagnostic Mode

                 HRF WS ground software shall support malfunction detection, trouble shooting and checkout procedures.

3.1.6.10.2   CSCI External Interface Requirements

3.1.6.10.2.1   The HRF workstation ground software shall interface with the following:

                          HRF hardware and software

                          SS communication

                          ISS EXPRESS

                          Data archive

                          Simulations and test

                 Details of these interfaces shall be defined in the SDD.

3.1.6.10.2.2   The HRF workstation ground software shall be able to verify health and status conditions of HRF experiment and ISS hardware and software. Details shall be defined in the SDD.

3.1.6.10.3   CSCI Internal Interface Requirements

                 Internal interface requirements shall be defined in an increment-specific SDD.

3.1.6.10.4   CSCI Internal Data Requirements

                 Internal data requirements shall be defined in an increment-specific SDD.

3.1.6.10.5   CSCI Adaptation Requirements

                 Any installation-dependent data shall be defined in an increment-specific VDD.

3.1.6.10.6   CSCI Safety Requirements

                 N/A

3.1.6.10.7   CSCI Data Privacy Requirements

                 Security requirements shall be defined in the SDD.

3.1.6.10.8   CSCI Environment Requirements

3.1.6.10.8.1   HRF workstation ground software shall be configurable to match the hardware platform, test hardware and software, and data.

3.1.6.10.8.2   HRF workstation ground software shall be required to operate within the environment defined in Section 3.1.6.2 of this HRD.

3.1.6.10.9   CSCI Software Quality Factors

There are no software quality factors defined at this time. Software quality factors defined in the future shall be documented in an increment-specific SDD.

3.1.6.10.10   CSCI Design and Implementation Constraints

None required at this time. Future design and implementation constraints shall be documented in an increment-specific SDD.

3.1.6.10.11   Precedence and Criticality of Requirements

All requirements shall be considered to be equally weighted.

4.0   <u>GENERAL DESIGN REQUIREMENTS</u>

The hardware controlled by this document shall comply with the general requirements stated in this section. These requirements are present to help guide the engineers in conducting the overall design of the hardware. Designers need to comply the wide range of topics found in this section. The majority of the requirements in this section are derived from LS-71000, HRF PRD.

The applicability of PRD requirements for the hardware covered by this document is dependent upon several factors. The first factor is the Commercial Off-The-Shelf (COTS) applicability matrix found in Appendix C of the PRD. This matrix identifies what PRD requirements are applicable and should flow down to this HRD. Note that the basis for the PRD direction is the assumption that the COTS item is completely unaltered once delivered from the vendor. Any COTS item delivered and then modified by HRF engineers cannot use PRD Appendix C.

The second factor is what type of HRF payload this HRD covers. The format basis of the PRD is dependent on the hardware type (that is, SIR drawer, stowed, or deployed payload). The following subsections shall reflect the appropriate PRD section from which the requirements originate.

The third factor is the requirements for safety. Proper verification of identified hazards can create additional design and test requirements for the hardware covered by this document.

4.1   HUMAN FACTORS

The capabilities and limitations of a crew person in plain clothes working in ISS shall be considered in designing the equipment. The HRF WS shall comply with the guidelines identified in SSP-52000, "International Space Station Flight Crew Integration Standard," and per the requirements identified in Sections 6.2.12, 6.3.12 and 6.4.12 of the PRD. The appropriate human factors standards are identified in Section II of the applicability matrix found in Appendix A.

The Human Computer Interfaces are as follows:

a. The HRF WS Computer Drawer shall support a visual display for presentation of text and graphics.

b. The HRF WS Computer Drawer shall support a keyboard for primary alphanumeric and text input.

c. The HRF WS Computer Drawer shall support a cursor control device.

4.2   MANNED SPACECRAFT CRITERIA AND STANDARDS

The hardware required for the HRF WS shall be designed to meet the requirements in JSCM-8080.5, "JSC Design and Procedural Standards Manual," per Section 6.0 of the PRD. Those standards identified in Section III of the applicability matrix in Appendix A shall be relevant, as specified, to the hardware identified in this HRD.

4.3   BONDING CONTINUITY

Parts shall be bonded to each other per the requirements of SSP-30245, "Space Station Electrical Bonding Requirements," as identified in Sections 6.2.2.4.2, 6.3.2.4.2 and 6.4.2.4.2 of the HRF PRD. Specifically:

Electrical bonding shall be in accordance with SSP 30245, with the exception that class S bonding is not required.

4.4   CLEANLINESS

4.4.1   External Surfaces

The external surfaces of the HRF WS shall meet the "visually clean-sensitive" requirements found in document SN-C-0005C, "National Space Transportation System Contamination Control Requirements." Implementation of the requirement shall be per JHB-5322, "Contamination Control Requirements Manual," and indicated on the hardware top assembly drawings.

4.4.2   Internal Surfaces

The internal parts of the HRF WS shall meet the GC requirements found in SN-C-0005C. Implementation of the requirement shall be per JHB-5322 and indicated on the hardware top assembly drawings.

4.4.3   In-Flight Cleanliness/Maintenance

The HRF WS in-flight cleanliness/maintenance is to be controlled through an on-orbit operations procedure. This section is not verifiable.

4.5   CONSTRUCTION REQUIREMENTS

4.5.1   Materials and Processes

4.5.1.1   General Materials and Processes

There are two requirements that the hardware covered by this HRD shall follow:

a. Materials and processes shall meet the requirements of SE-M-0096A, "General Specification for Materials and Processes, Requirements for JSC Controlled Payloads," per Sections 6.2.11.1.1, 6.3.11.1.1 and 6.4.11.1.1 of the HRF PRD.

b. Materials and processes shall meet the requirements of NSTS-1700.7B and NSTS-1700.7B ISS Addendum per Sections 6.2.11.1.1, 6.3.11.1.1 and 6.4.11.1.1 of the HRF PRD.

Because COTS hardware shall be used extensively, many undesirable materials will exist in the hardware systems. The primary materials to be identified are wire insulation, printed circuit board materials, and printed circuit board coatings. A list of all materials that can be identified should be provided to JSC-EM2 and Material Usage Requests processed as required. Offgas testing shall be performed on the flight system or the flight backup system. Selection of new materials shall be made using JSC-09604,

"Materials Selection List for Space Hardware Systems," as a guideline where possible.

4.5.1.2   Stress Corrosion

All materials used shall meet the requirements of MSFC-SPEC-522B, "Design Criteria for Controlling Stress Corrosion Cracking," per Sections 6.2.11.1.3, 6.3.11.1.3 and 6.4.11.1.3 of the HRF PRD.

COTS products shall not be held to these requirements.

4.5.1.3   Fracture/Fatigue

The HRF WS shall be designed to prevent the creation or propagation of any material failures per the requirements of the LS-71010, "Fracture Control Plan for the Human Research Facility Payloads and Racks."

4.5.2   Screw Threads

All straight screw threads shall be in accordance with MIL-S-7742B, "General Specification for Screw Threads, Standard, Optimum Selected Series," and/or MIL-S-8879C, "General Specification for Screw Threads, Controlled Radius Root With Increased Minor Diameter."

COTS products shall not be held to these requirements.

4.5.3   Fasteners

All fasteners shall be purchased with materials certification information included in the delivery and placed in a controlled storage facility. Any fastener over the size designation of number 8 shall be tested per the requirements of JSC-23642, "JSC Fastener Integrity Testing Program."

Due to the extensive use of COTS hardware systems, implementation of this requirement is not absolute, particularly for non-structural members. In these cases, non-adherence must be reviewed with and approved by the JSC Structures and Mechanics Working Group.

4.5.4   Locking Devices

4.5.4.1   Thread Locking Adhesive

Any liquid locking substance shall be applied per MIL-S-33540, "General Specification for Liquid Locking Compounds."

4.5.4.2   Lock wire

Lock wire shall be applied when necessary per MS33540J, "General Practices for Safety Wiring and Cotter Pinning."

4.6 WORKMANSHIP

Workmanship shall be of aerospace quality and shall conform to high grade aerospace manufacturing practices as directed by LS-71030, "Quality Assurance Plan for the Human Research Facility."

Non-EM Hardware. For hardware not built onsite or under EM (Engineering) direction, the following industrial, military, and NASA-recognized workmanship standards shall be used in the design and manufacture of electrical/electronic equipment for high-reliability applications.

a) Soldering - Through-Hole Technology. For soldering of through-hole technology devices, using hand, wave, or reflow processes:

NASA-STD-8739.3, "Soldered Electrical Connections," December 1997.

b) Soldering - Surface Mount Technology (SMT). For soldering of surface mount technology devices:

NAS 5300.4(3M), "Workmanship Standard for Surface Mount Technology," May 1996.

c) Cable and Harness. For requirements to produce mechanically and electrically stable interconnecting cable and harness assemblies that connect electrical/electronic and electromechanical components:

NASA-STD-8739.4, "Crimping, Interconnecting Cables, Harnesses and Wiring," February 1998 or LS-60035, "Life Sciences Flight Cable Fabrication Practices and Specifications," May 1986.

d) Crimping. For requirements to produce mechanically and electrically stable crimp terminations for interconnecting cable and harness assemblies that connect electrical/electronic and electromechanical components:

NASA-STD-8739.4, "Crimping, Interconnecting Cables, Harnesses and Wiring," February 1998.

e) Conformal Coating and Staking. For requirements to ensure reliable staking and conformal coating of printed circuit boards and electronic assemblies:

NAS 5300.4(3J-1), "Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies," May 1996.

f) Electrostatic Discharge (ESD) Control. For establishing ESD control requirements for items that are ESD sensitive:

NASA-STD-8739.7, "Electrostatic Discharge Control (Excluding Electrically Initiated Explosive Devices)," December 1997.

g. Rigid Printed Wiring Board (PWB) Design. For the design of rigid organic printed boards and other forms of component mounting (homogeneous, reinforced, or inorganic-composite) and interconnecting (single, double, or multilayer) structures:

IPC-2221, "Generic Standard on PWB Design," March 1998
IPC-2222, "Sectional Standard on Rigid PWB Design," March 1998

h. Rigid PWB Design. For qualification and performance specifications of rigid printed boards (single, double, metal-core, or multilayer structures), incorporating plated-through and non-plated-through holes, with or without buried or blind vias:

IPC-6011, "Generic Performance Specification for Printed Boards," July 1996

IPC-6012, "Qualification and Performance Specification for Rigid Printed Boards," July 1996

S312-P-003B, "GSFC, Procurement Specification for Rigid Printed Boards for Space Applications and Other High Reliability Users," July 1997.

4.7   INTERCHANGEABILITY AND REPLACEABILITY

Interchangeability requirements are not applicable to detailed parts of permanent assemblies such as welded assemblies or matched detailed parts such as lapped components. Interchangeability requirements do not apply to custom-fitted or custom-sized items.

4.7.1   Interchangeability

All replaceable parts or assemblies having the same part number shall be directly and completely interchangeable with each other with respect to installation and performance.

4.7.2   Replaceability

Each assembly shall be designed to be replaceable with all other assemblies having the same part number without requiring the replacement of the other assemblies.

4.7.3   Maintainability

4.7.3.1   On-Orbit

On orbit Maintainability shall be cleaning the inlet vents of the HRF WS Computer drawer and cleaning the keyboard/display as required.

4.7.3.2   Ground

Ground Maintainability shall be cleaning the inlet vents of the HRF WS Computer drawer and cleaning the keyboard/display as required.

4.8   COLOR

4.8.1   Stowed Hardware

Stowed hardware shall be anodized turquoise. The flag note on all drawings shall be as follows:

"APPLY ANODIC COATING PER MIL-A-8625F, TYPE II, CLASS 2, DYED TURQUOISE"

For reference only: The recommended vendor is Turnkey Coating in Houston.

Reference FED-STD-595, Color Specification 15187.

4.8.2   Rack Mounted Hardware

The front panel (window) shall be colored off white as per SSP 50008B, "International Space Station Interior Color Scheme," Section 3.2.7. Flag notes shall be as follows:

"COLOR TO MATCH FED-STD-595B COLOR IDENTIFICATION #27722"

4.9   NON-IONIZING CONDUCTED RADIATION

The HRF WS shall be in accordance with LS-71016, "Electromagnetic Compatibility Control Plan for the Human Research Facility."

4.9.1   Emission

The HRF WS will be in accordance with LS-71016.

4.9.2   Susceptibility

The HRF WS will be in accordance with LS-71016.

4.10   ILLUMINATION

The HRF WS shall meet the illumination requirements specified in HRF PRD, Sections 6.2.9.4, 6.3.9.4 and 6.4.9.4.

4.11   GROUND HANDLING

4.11.1   Ground Handling Load Factors

The HRF WS shall meet the Ground Handling Load Factor requirements referenced in the HRF PRD, Sections 6.2.1.8.1, 6.3.1.8.1 and 6.4.1.8.1. The choice of hardware shipping/storage containers, procedures, and storage environments can minimize or negate this particular environment's effect on the hardware. Packaging, handling and shipping shall be in accordance with Section 10.4, "Hardware Delivery for Flight," of this document.

4.11.2   Shock Criteria

The HRF WS shall meet the Shock Criteria requirements referenced in the HRF PRD, Sections 6.2.1.8.2, 6.3.1.8.2 and 6.4.1.8.2.

4.11.3   Bench Handling - Stowed/Deployed Hardware and Subassembly Only

N/A

4.12   USEFUL LIFE

The useful life of the equipment (equivalent to full life) is the sum of operational life and shelf life. The HRF WS useful life shall be a minimum of 10 years, with spares and replacement. This requirement is imposed by the HRF PRD.

4.12.1   Operational Life (Cycles)

Operational life applies to any hardware that deteriorates with the accumulation of operating time and/or cycles and thus requires periodic replacement or refurbishment to maintain acceptable operating characteristics. Operational life includes the usage during flight, ground testing, and pre-launch operations. All components of the HRF WS have an operational life limit of 10 years except those identified as having limited life, see Section 4.12.3.

4.12.2   Shelf Life

Shelf life is defined as that period of time during which the components of a system can be stored under controlled conditions and put into service without replacement of parts (beyond servicing and installation of consumables). The HRF WS shall have a shelf life limit of 10 years.

4.12.3   Limited Life

Limited life is defined as the life of a component, subassembly, or assembly that expires prior to the stated useful life in Section 4.5 of this HRD. Limited life items or materials, such as soft goods, shall be identified, and number of operations cycles shall be determined. Limited life items shall be tracked on a limited life list that is maintained as a part of the hardware acceptance data pack. The limited life components are recorded in the HRF WS Limited Life Items List (LNES-32325). A log will be kept by the HRP personnel to record the amount of use during flight and ground testing.

4.13   ELECTRICAL, ELECTRONIC, AND ELECTROMAGNETIC (EEE) PARTS REQUIREMENTS

4.13.1   General Requirements

Parts shall be controlled in accordance with:

a. NHB 5300.4(1F), "Electrical, Electronic, and Electromechanical (EEE) Parts Management and Control Requirements for NASA Space Flight Programs."

b. SSP 30312, "Electrical, Electronic, and Electromechanical (EEE) and Mechanical Parts Management and Implementation Plan for Space Station Program."

c. COTS, see 4.13.3.

4.13.2   Part Selection

Part selection shall be in accordance with:

a. MIL-STD-975, "NASA Standard Electrical, Electronic, and Electromechanical (EEE) Parts List."

b. SSP-30423, "Space Station Approved Electrical, Electronic, and Electromechanical (EEE) Parts List."

c. SSQ-25002, "Supplemental List of Qualified Electrical, Electronic, Electromechanical (EEE) Parts, Manufacturers, and Laboratories (QEPM&L)."

d. Semiconductors shall be JANTXV in accordance with MIL-S-19500, "General Specifications for Semiconductor Devices." Diodes shall have a metallurgical bond. Passive parts shall be at least the second highest level of appropriate MIL-ER (Military Established Reliability).

e. SSP-30512, "Space Station Ionizing Radiation Design Environment."

f. COTS, see 4.13.3.

4.13.3   COTS/Modified COTS

To the extent practical, COTS and modified COTS must meet the above requirements to assure the hardware/design compliance to the EEE part selection criteria for the proposed applications and corresponding criticalities. This includes a risk assessment, electrical stress analysis, and data delivery on information such as-designed/as-built EEE parts, list, construction history, Government and Industry Data Exchange Program Alerts, part obsolescence, radiation susceptibility, and/or prior history.

Where no alternative is available, nonmilitary parts, components and subassemblies may be used, but screening of these items shall be accomplished through burn-in. Screening shall be completed (100%) on all flight hardware (units).

Burn-in may be accomplished at the component or assembly level. Burn-in is specified as:

a. 72-hour continuously at room ambient temperature while functioning.

b. 96-hour continuously at a specified controlled temperature while functioning.

Controlled temperature is defined as 15 °C below the maximum rating of the device with the lowest temperature rating in the article under test.

4.14   BATTERY REQUIREMENTS

Batteries shall follow the guidelines of JSC-20793, "Manned Space Vehicle
Battery Safety Handbook," and must be approved for intended use by the JSC
power systems branch. Batteries shall be two failures tolerant to a catastrophic
event. Except for high pressure cells (e.g., nickel hydrogen), batteries are
considered sealed containers. Those that contain hazardous fluids shall be leak-
before-burst design. All cells in a battery critical for safety shall be lot certified.

5.0   ENVIRONMENTAL DESIGN REQUIREMENTS

5.1   GENERAL

The HRF WS shall be designed to meet the performance requirements during and after exposure to the environments specified below. The requirement levels listed below originate from the HRF PRD except in those cases where certain environments have been established by appropriate JSC test, structural, or thermal organizations. In these cases, the hardware will meet the requirements so established. The specific method of compliance for each of the following requirements is described in the Verification Matrix found in Appendix B as well as in the appropriate sections below.

5.2   TEMPERATURE RANGES

The HRF WS shall meet the temperature range in the HRF PRD, Sections 6.2.9.1.1.1, 6.3.9.1.1.1 and 6.4.9.1.1.1.

5.2.1   Operating Temperature

The HRF WS hardware shall be designed to operate at a controlled cabin temperature range (high and low) of 65 °F to 85 °F air inlet temperature.

5.2.2   Non-Operating Temperature

The HRF hardware shall be designed to operate after withstanding a Mini-Pressurized Logistical Module air temperature range of 36 °F to 120 °F. Parts that cannot survive these temperatures shall be protected to stay within the actual storage temperature of the part (for example, COTS).

5.3   PRESSURE

The HRF WS shall meet the pressure requirements in the HRF PRD, Paragraphs 6.2.9.2.1, 6.3.9.2.1 and 6.4.9.2.1.

5.3.1   Operating Pressure

The HRF WS hardware shall be designed to operate at a controlled cabin pressure range of 13.9 to 14.9 psia.

5.3.2   Non-Operating Pressure/Rate of Change

The HRF WS hardware shall be designed to fail safe after being exposed to a pressure range of 14.9 to 1×10^{-7} psia.

5.3.3   Rate of Change

The HRF WS shall be designed such that a safety hazard will not be created after being exposed to a rate of de-pressurization equal to .5 psi/minute, and a maximum re-pressurization rate of 2 psi/min, as defined in HRF PRD, Paragraphs 6.2.1.7.1, 6.3.1.7.1 and 6.4.1.7.1.

5.4   HUMIDITY

    The HRF WS shall meet the humidity requirements in the HRF PRD, Paragraphs 6.2.9.1.3, 6.3.9.1.3 and 6.4.9.1.3. The HRF hardware shall be designed to operate during exposure to a controlled environment having air with 25-70% humidity.

5.5   OXYGEN ENVIRONMENT

    The HRF WS shall meet the oxygen environment requirements in the HRF PRD, Paragraphs 6.2.9.1.4, 6.3.9.1.4 and 6.4.9.1.4; i.e., the hardware shall be designed to operate in the controlled oxygen environment of less than or equal to 24.1% oxygen concentration.

5.6   CONTAMINATION AND WASTE MANAGEMENT

    The HRF WS shall meet the contamination and waste management requirements in the HRF PRD, Paragraphs 6.2.9.2, 6.3.9.2 and 6.4.9.2.

5.7   RANDOM VIBRATION

    The HRF WS hardware shall be designed to withstand the following launch level random vibration environment.

    NOTE: Stowed hardware will withstand this environment with the correct use of packaging (foam):

TABLE 5-1. RANDOM VIBRATION ENVIRONMENT

Frequency	Level	
20 Hz	.005	g^2/Hz
20-70 Hz	+3.3	dB/octave (oct)
70-200 Hz	0.02	g^2/Hz
200-2000 Hz	-4.0	dB/oct
2000 Hz	.00093	g^2/Hz
Composite	3.1	g_{rms}

5.8   ACCELERATION

5.9   ACOUSTIC EMISSION LIMITS

    The sound pressure level of HRF WS shall not exceed the value allocated by the procedure described in the HRF Acoustics and Noise Control Analysis Plan, LS-71011, when measured at two feet from the front of the hardware item surface.

Compliance to this requirement will only be tested at the integrated rack level, although engineering development tests may be completed at the hardware system level to acoustically characterize hardware at the box level.

5.10   IONIZING/NON-IONIZING NON-CONDUCTIVE RADIATION

5.10.1   Ionizing

5.10.1.1   Emission

   a. The HRF WS hardware shall be designed to meet the ionizing radiation requirement in the SSP 50005B, Paragraph 5.7.2.2.2C.

   b. Payload ionizing radiation emissions shall not exceed 2 millirads silicon per day measured one centimeter from any surface (in accordance with the HRF PRD, Sections 6.2.9.3.2, 6.3.9.3.2, 6.4.9.3.2). Payloads shall also be in accordance with JHB 8080, Section G 26.

5.10.1.2   Susceptibility

The HRF WS hardware will use JSCM Section E22, "Ionizing Radiation Effects" and SSP 30512, "Space Station Ionizing Radiation Design Environment" as design guidelines.

5.10.2   Non-Ionizing

HRF WS hardware shall be in accordance with LS-71016, "Electromagnetic Compatibility Control Plan for the Human Research Facility."

5.10.2.1   Emission

HRF WS hardware shall be in accordance with LS-71016, "Electromagnetic Compatibility Control Plan for the Human Research Facility," Section 4.2.2.2.3.

5.10.2.2   Susceptibility

HRF WS hardware will be in accordance with LS-71016, "Electromagnetic Compatibility Control Plan for the Human Research Facility," Section 4.2.2.2.4.

6.0   CERTIFICATION APPROACH

6.1   GENERAL

A formal design certification program shall be conducted to demonstrate that the HRF WS hardware meets all of the design requirements of this HRD. For the HRF program, certification has been established to encompass all of the acceptance and qualification procedures utilized to show compliance with the design requirements. All appropriate documentation resulting from this certification program shall be collected in a certification package (Section 6.3.3) and delivered to JSC Safety and Mission Assurance (S&MA) and engineering organizations for review and approval (i.e., Design Certification Review).

6.2   CERTIFICATION RATIONALE

Certification of the HRF WS Hardware shall be by similarity, analysis, inspection, demonstration, and/or test at the component and/or the system level. The certification methods are described below.

6.2.1   Similarity

Certification data for hardware components previously qualified or flown shall be reviewed to verify that these components' prior certification requirements meet or exceed the current mission requirements. The review shall cover structures, materials, environmental, and operational requirements.

6.2.2   Analysis

Hardware not previously qualified or flown shall be analyzed when analysis is the most efficient way to demonstrate capability to meet or exceed expected environmental conditions.

6.2.3   Inspection

The hardware shall be thoroughly inspected or reviewed to validate that it has been built to the individual assembly drawings. Inspection or review shall also be used when it is more efficient or applicable to demonstrate compliance to requirements rather than perform calculable testing or analysis.

6.2.4   Demonstration

The hardware shall be certified by observation that verifies the design characteristics such as human factors, maintenance, operation, and access features. The pass/fail criterion of a demonstration is qualitative. Considering the design requirement, the operation or assessment shall be acceptable based upon the judgment of those approved individuals (i.e., quality assurance (QA), human factors, astronaut, etc.) who witness the demonstration.

6.2.5   Test

The hardware shall be tested to verify that the design can withstand the environmental conditions and operate within the specified functional tolerances. Functional tests shall be performed before, during (if applicable), and after each environmental test. When testing is the chosen method, the tests shall be

performed on appropriate hardware. All class I hardware shall be subjected to test verifiable acceptance requirements. Qualification level requirement testing shall use qualification hardware that is of identical configuration as the intended flight end items.

6.3   CERTIFICATION MATRIX

The certification matrix serves a dual purpose. For the HRD, this matrix indicates the qualification/acceptance compliance plan for each applicable requirement (See Appendix B). Once the project has completed all qualification and acceptance procedures on the qualification unit, a certification data pack shall be developed. The certification matrix is then modified to create the certification compliance table. Serving as the basis of the certification report, the certification compliance table is attached to the front of the certification data package.

6.3.1   Certification Plan

The overall certification plan for the HRF WS is defined by the completed certification matrix in this HRD. The certification document column is left blank since the matrix is describing the plan not the results. The matrix must detail how the requirements will be verified per the following:

1. Whether the requirement is for acceptance and/or qualification.

2. Which of the previously mentioned certification rationales will be applicable for fulfilling each requirement.

3. Which of the acceptance and/or qualification procedures will be applicable for fulfilling each requirement.

4. An explanation on the compliance procedure or plan in the comment column.

5. Identification of the hardware system test configuration in the comment field.

6.3.2   Certification Compliance

As certification data is completed (e.g., Task Performance Sheet (TPS), analysis, reports, waivers), verification information is added to the certification matrix. This version of the certification matrix is the project's method of reporting that all certification requirements have been properly met. It will replace a formal document type report and will be the basis of the certification package. The "certification document" column is filled in with document number(s) (i.e., analysis reports or TPS) that describe how the design requirements were verified. Additional certification information is added to the "comments" column as needed.

6.3.3   Certification Package

The hardware certification package shall consist of a GFE Certification Approval Request, the certification matrix containing the completed in "compliance certification" column, and all back-up information identified in the compliance table, such as TPSs, memos, analyses, software data files, and

drawings. The GCAR shall also include the safety analysis (a preliminary hazard and operational hazard analysis) performed on the hardware.

6.4   TESTING PROGRAM

All certification tests (both qualification and acceptance type) described in the certification matrix shall require full quality coverage. Quality personnel must be notified prior to all certification test activities. For large tests, Test Readiness Reviews (TRR) shall be held. It shall be the responsibility of the test director and/or the program test coordinator to notify the appropriate personnel so that they can participate in the TRR and attend the testing. Failure to notify quality personnel of a TRR could result in a delay or voiding of the certification test.

All testing and testing build-up shall be accomplished by TPS in accordance with LS-71030, "Quality Assurance Plan for the Human Research Facility."

For certification, functional tests shall be performed before, during (if applicable), and after major tests. These functional tests shall verify that the environment or level of the test had no detrimental effects on the hardware. All tests used for certification shall be approved by the JSC technical monitor and quality engineering.

In the event of a failure or non-conformance of a test article to its specified design requirement during the certification tests, perform the following sequence of events:

1.   Halt the test.

2.   Notify the Project Manager or his representative immediately.

3.   Immediately initiate a Discrepancy Report (DR) which describes the failure or non-conformance condition and includes events preceding the observed failure. The test shall continue at the discretion of the Project Manager or his representative.

4.   The Test Control Board shall be convened to determine the type and cause of failure and establish corrective actions. The Board shall consist of the appropriate NASA project lead, hardware engineers, and quality and safety representatives.

The rejected item could be withheld from further certification testing until the reason for rejection is eliminated and remedial action has been described on the DR. On completion of remedial action, applicable acceptance tests shall be performed and pertinent certification tests repeated.

7.0   ACCEPTANCE APPROACH AND TESTS

7.1   GENERAL

An acceptance validation process shall be conducted on all parts, components, and assemblies to determine conformance to design specifications and to released drawings. This process shall include inspections on parts and materials and tests performed at intermediate points during production, final assembly, and final shipment of the hardware.

The necessity for an Acceptance Data Package (ADP) for the hardware shall be evaluated on a case-by-case basis by the hardware's assigned quality engineer. At a minimum for the hardware, JSC Form 911 tags shall be used to maintain transfer and usage information instead of a formal ADP. The content of the ADP is defined in Appendix A of the HRF PRD.

7.2   ACCEPTANCE TESTS

7.2.1   Pre-Delivery Acceptance (PDA) Test Requirements

A PDA shall be performed by the responsible manufacturing parties after the complete fabrication and assembly has been conducted for all class I deliverable assemblies. This test shall include verification of software interface and operation. The PDA must be completed before hardware certification testing begins. It is a full functional test and inspection that validates that the hardware operates per the design requirements and that it is constructed per released engineering drawings. All PDAs shall be approved by the hardware's JSC technical monitor and quality engineering, as well as by the contractor quality engineering function (if applicable). The following are standard steps that each PDA shall contain:

1. Conformance to Drawing. Verify that the hardware conforms to released engineering drawings.

2. No Sharp Edges. Inspect the hardware to verify that there are no sharp edges or corners present.

3. Proper Identifying Markings. Verify that the hardware has the proper part number and serial number (if applicable) on it.

4. Cleanliness. All PDAs shall include verification that all surfaces (external, internal, etc.) are to cleanliness level of Section 4.4 of this document.

7.2.2   Pre-Installation Acceptance (PIA) Test Requirements

Pre-Installation Acceptance (PIA) tests shall be conducted on all components and assemblies to determine conformance to design specifications as a basis for acceptance for flight usage. PIA tests shall be performed prior to shipment for flight after all certification testing and analyses are completed. PIA tests can also be performed upon post shipment and/or preinstallation for flight.

7.2.3   Functional Test Requirements

Functional tests are performed to validate the operation of the hardware to the requirements of Section 3.1.2 of this HRD. Functional tests make up the core

of certain tests (like a PDA) and can be performed before and after environmental testing. The functional performed prior to testing established the functional state (or baseline) of the hardware while the functional done after testing evaluates the hardware's ability to withstand the test levels.

7.2.4   Environmental Acceptance Test Requirements

Certain flight hardware shall be exposed to environmental acceptance tests to verify workmanship, manufacturing and assembly conformance to drawings. The flight hardware that is exposed to vibration environments or is of significant complexity shall be exposed to an acceptance vibration test level. The acceptance test levels for HRF hardware are defined in Section 7.4.1 of the HRF PRD.

7.2.4.1   Acceptance Vibration Test

All HRF class I hardware except for stowed peripherals (flight and qualification units) hardware shall be tested to the following acceptance level random vibration environment to verify that the unit was properly assembled per drawings and procedures:

TABLE 7-1. RANDOM VIBRATION TEST PARAMETERS

Frequency	Level	
20 Hz	.010	g^2/Hz
20-80 Hz	+3.0	dB/oct
80-350 Hz	0.04	g^2/Hz
350-2000 Hz	-3.0	dB/oct
2000 Hz	.007	g^2/Hz
Composite	6.1	g_{rms}

The vibration test shall be for 60 seconds for all three axes.

7.2.4.2   Acceptance Thermal Cycle Test

The hardware shall be designed to withstand a thermal cycle test. The test level shall be developed based upon the limitation of the hardware (especially if COTS are included). The hardware shall be exposed to the acceptance test value of 50 °F above and below the normal operating temperature (65-85 °F), but shall be operated only at the operational range limits of Section 5.2 of this HRD.

The hardware shall be exposed to 1.5 cycles.

A full functional checkout must be performed pre and post test. An abbreviated functional checkout must be performed at selected temperatures during the thermal test.

8.0   QUALIFICATION APPROACH AND TESTS

8.1   GENERAL

The following sections list the qualification testing levels for several of the natural environments listed in Section five (5) of this HRD. This information shall be included in the comments column of the certification matrix in Appendix B.

8.2   QUALIFICATION TESTS

8.2.1   Functional Test Requirements

Functional tests are performed to validate the operation of the hardware to the requirements of Section 3.1.2. Functionals make up the core of certain tests (like a PDA) and can be performed before and after environmental testing. The functional done prior to testing established the functional state (or baseline) of the hardware while the functional done after testing evaluates the hardware's ability to withstand the test levels.

Abbreviated functional checkout will be used to test the functional state of the hardware during some environmental testing (i.e., thermal, vibration, bench handling, etc.). The intended use of an abbreviated functional testing is to verify nominal hardware functionality between test stages.

8.2.2   Qualification Acceptance Random Vibration Test

The HRF WS hardware shall be tested to the following qualification acceptance level random vibration environment. All rack-mounted, soft-stowed, and deployed (for launch) hardware shall be exposed to this level by using a qualification flight unit.

TABLE 8-1. QUALIFICATION RANDOM VIBRATION
TEST PARAMETERS

Frequency	Level	
20 Hz	0.017	8^2/Hz
20-80 Hz	+3.0	dB/oct
80-350 Hz	0.067	g^2/Hz
350-2000 Hz	-3.0	dB/oct
2000 Hz	0.118	g^2/Hz
Composite	7.9	g_{rms}

The vibration test shall be for 120 seconds for each of the three axes.

A full functional must be performed before and after the Qualification Acceptance Vibration Test (QAVT). An abbreviated functional must be performed after each axis has been tested.

Successful completion of the QAVT will certify hardware for two modifications/re-acceptance test. Certification for each additional modification requires an additional 60 seconds of QAVT.

8.2.3   Qualification Random Vibration Test

The information in this section is only applicable for rack mounted hardware.

The HRF WS shall be tested to the following launch level random vibration environment:

Frequency	Level	
20 Hz		
20-80 Hz	+3.0	dB/oct
80-350 Hz	0.067	g^2/Hz
350-2000 Hz	-3.0	dB/oct
2000 Hz		
Composite	7.9	g_{rms}

The vibration test shall be for 120 seconds (minimum) for each of the three axes.

Successful completion of the Qualification Vibration Test (QVT) will certify stowed or rack mounted hardware for three mission (launch/landing cycles). Certification for each additional mission requires an additional 30 seconds of QVT.

8.2.4   Qualification Thermal Cycle Test

The hardware shall be designed to withstand a thermal cycle test environment. The test level shall be developed based upon the limitation of the hardware (especially if COTS are included). The hardware shall be exposed to the certification test value of 60 °F above and below the normal operating temperature (65 - 85 °F) within the operating temperature range of the end item, but shall be operated only at the operational range limits of Section 5.2 of this HRD. The hardware shall be exposed to 7.5 cycles.

A full functional must be performed pre and post test. An abbreviated functional must be performed at selected temperatures during the thermal test (TT).

8.2.5   <u>Limit and Ultimate Loads</u>

This section is for rack mounted and deployed hardware only.

The HRF WS's limit loads specified in Section 3.1.2 of this HRD shall be used to calculate the ultimate loads per the instructions of LS-71012, "Structural Analysis Plan for the Human Research Facility." A stress analysis shall be performed to document that the design has positive margins of safety at all limit loads.

8.2.6   <u>Fracture/Fatigue</u>

HRF WS hardware shall be designed to prevent the creation or propagation of any material failures per the requirements of LS-71010. A fracture analysis shall be done to document that the design does not propagate any material failure due to loading.

9.0   <u>CONFIGURATION AND CHANGE CONTROL</u>

Configuration of this equipment shall be established through appropriate design reviews. A baseline configuration for flight hardware shall be released via JSC drawings in accordance with JSCM-8500, "JSCM Engineering Drawing Practices." These released engineering drawings shall define the configuration sufficient to allow storage accommodations definition, end item identification, end item modification, and end item fabrication/assembly, as appropriate. The end items of this document shall be configured in accordance with the configuration on the top assembly drawings as listed in Section 2.4 of this document. Fabrication and assembly shall comply with approved drawings and Drawing Change Notices.

Any changes to this HRD or the released drawings shall be approved via CR to the HRF CCB per LS-71005, "HRF Configuration Management Plan." Not all drawing changes are required to go to the CCB, but those that affect the fit, form, and/or function of the hardware shall be approved at the CCB.

10.0   SAFETY AND MISSION ASSURANCE (S&MA) AND QUALITY
          ASSURANCE PLAN

10.1   GENERAL REQUIREMENTS

          The hardware covered by this HRD shall abide by the following HRF system
          level plans:

          1.   LS-71002   System Safety Program Plan for the Human
                                      Research Facility

          2.   LS-71022   Maintainability Plan for the Human Research
                                      Facility

          3.   LS-71026   Reliability Plan for the Human Research Facility

          4.   LS-71030   Quality Assurance Plan for the Human Research
                                      Facility

          In addition, this HRD establishes that the design and construction of the
          hardware and its components shall ensure ease and rapidity of repair and
          maintenance while on the ground and during mission use. The design shall be
          such that the use of special tools shall be minimized for normal maintenance
          and checkout of the hardware.

          This HRD serves as the certification and acceptance plan for the hardware;
          therefore, a separate certification plan is not required. The plan specified here
          shall be deemed acceptable by S&MA and quality engineering by way approval
          signatures on this document and shall be carried forth through the end of the
          project activity.

10.2   CRITICALITY

          The end items of this HRD shall have a criticality assigned to them. The
          criticality will be based upon the analysis found in the hardware's Failure
          Modes and Effects Analysis and Critical Items List (FMEA/CIL) document
          prepared per LS-71026. The FMEA shall be used to design to minimum risk
          and increased reliability that ensures mission success and no injury or loss of
          crew, shuttle, or station. There shall be adequate redundancy applied to prevent
          injury to crew and damage to the shuttle during launch or station during on-orbit
          operations as identified in the FMEA/CIL documents.

10.3   SAFETY AND MISSION ASSURANCE DOCUMENTATION LIST

          Table 10-1 on the following page shall be added to the Verification Matrix to
          indicate compliance with the requirement to produce and approve the
          certification document.

10.4   HARDWARE DELIVERY FOR FLIGHT

          Cleaning, preservation, packaging, handling, storage, and shipping of the end
          items of this requirements document shall be in accordance with MIL-STD-
          794B. The shipping personnel shall be aware that these requirements must be
          followed in order to protect the hardware from handling and transportation
          damage as well as exposure to natural environments that could cause harm to
          the hardware. Once the hardware has been prepared for flight delivery, a JSC

Form 1027 shall be completed and submitted for approval to quality engineering. Prior to hardware release, the QA record center and the flight hardware certification report shall be reviewed to ensure compliance and that no open records exist on the specified hardware item.

APPENDIX A

HRD APPLICABILITY MATRIX

No.	Reference Document Item No.	Abbreviated Requirement Title	App.	HRD Para. No.	Comments
	SECTION I				
	FRD PARA. NO.				
	24.2	FUNCTIONAL REQUIREMENTS		3.1	
1	24.2.1	Providing high-capacity mass-storage devices	X	3.1.2.1.8 3.1.2.1.11 3.1.2.1.12 3.1.2.4.1	
2	24.2.2	Upload/Download software from/to ground	X	3.1.2.1.11 3.1.2.1.14	
3	24.2.3	High resolution graphics display	X	3.1.2.1.1 3.1.2.1.2 3.1.2.1.4 3.1.2.1.5 3.1.2.3.2	
4	24.2.4	DSP and dual 3-D graphics accelerators capability	X	3.1.2.1.3 3.1.2.1.4	
5	24.2.5	Rapid reconfiguration and reprogramming possible	X	3.1.2.1.1 3.1.2.1.8 3.1.2.1.12	
6	24.2.6	Real-time processing supported	X	3.1.2.1.1 3.1.2.1.2	
7	24.2.7	Multichannel equal-interval sampling measurement	X	3.1.2.1.3	
8	24.2.8	Variety of O/S supported	X	3.1.2.1.1 3.1.2.1.2 3.1.2.1.8	
9	24.2.9	Accepts pre-developed software	X	3.1.2.1.1 3.1.2.1.3 3.1.2.1.8 3.1.2.1.15	

X = Applicable   N/A = Not Applicable   E = Exception

No.	Reference Document Item No.	Abbreviated Requirement Title	App.	HRD Para. No.	Comments
10	24.2.10	Compatible with ground version of system	X	3.1.2.1.1 3.1.2.1.2 3.1.2.1.5 3.1.2.1.6 3.1.2.1.15 3.1.2.2.1	
11	24.2.11	Provides task simulations	X	3.1.2.1.4	
12	24.2.12	Upgradeable	X	3.1.2.1.1 3.1.2.1.2 3.1.2.1.3 3.1.2.1.8 3.1.2.1.12 3.1.2.1.14 3.1.2.4.2	
13	24.2.13	Capable of video storage and NTSC video generation	X	3.1.2.1.2	
14	24.2.14	Supports voice input and sound output	X	3.1.2.1.3 3.1.2.1.8 3.1.2.1.13	
15	24.2.15	Accepts/use graphics software	X	3.1.2.1.1	
16	24.2.16	Accommodates video capture and analysis software	X	3.1.2.1.2	
17	24.2.17	Provides multiple serial interfaces	X	3.1.2.1.5 3.1.2.1.6 3.1.2.1.7 3.1.2.2.3	
18	24.2.18	Provides Ethernet and Payload Bus connectivity	X	3.1.2.1.14	
19	24.2.19	Accommodates fastest processor available	X	3.1.2.1.1	
20	24.2.20	Provides A/D card, 16-bit resolution	X	3.1.2.1.3	Current design provides 12-bit resolution.
21	24.2.21	Option to support head mounted display	X	3.1.2.1.4	
22	24.2.22	Provides voice recognition system	X	3.1.2.1.3	
23	24.2.23	Provides digital sound recording and playing	X	3.1.2.1.3 3.1.2.1.13	
24	24.2.24	Accommodates station connectivity	X	3.1.2.1.7	

X = Applicable   N/A = Not Applicable   E = Exception

No.	Reference Document Item No.	Abbreviated Requirement Title	App.	HRD Para. No.	Comments
				3.1.2.1.14	
25	24.2.25	Printer support	X	3.1.2.1.15	
	24.3	TECHNICAL SPECIFICATIONS			
26	24.3.1	Adjustable Work surface and foot restraints	N/A		Not part of HRF WS System. ISS Bogne arm is adjustable.
27	24.3.2	17", 24-bit color high-resolution display	X	3.1.2.1.5 3.1.2.3.2 3.1.2.3.3	
28	24.3.3	Non-fixed components be Adjustable and attachable to seat tracks	X	3.1.2.2.2 3.1.2.3.1	
29	24.3.4	Non-fixed components have attachments that allow various arrangements/orientations	X	3.1.2.2.2 3.1.2.3.1	
30	24.3.5	Minimum restriction on software type	X	3.1.2.1.1 3.1.2.1.3	
31	24.3.6	128 MB RAM, 8 90 GB hard disk; removable mass storage	X	3.1.2.1.1 3.1.2.1.2 3.1.2.1.8 3.1.2.1.12 3.1.2.4.1 3.1.2.4.4	
32	24.3.7	3D graphics with Z buffering, min. 60,000 triangles/sec., 24-bit color RGB output 1280 x 1024	X	3.1.2.1.16	
33	24.3.8	Wide variety of input devices supported	X	3.1.2.1.7 3.1.2.2.3	
34	24.3.9	PCMCIA slot available	X	3.1.2.1.8	
35	24.3.10	File compressor utility S/W	X	3.1.6.6	
36	24.3.11	Voice input, sound output, front panel headphone output	X	3.1.2.1.3 3.1.2.1.13	
	24.4	RACK CONFIGURATION REQUIREMENTS			
37	24.4.1	4-PU active drawer, 4-PU stowage drawer	X	3.1.4.2.1 3.1.5.4.1	

X = Applicable   N/A = Not Applicable   E = Exception

No.	Reference Document Item No.	Abbreviated Requirement Title	App.	HRD Para. No.	Comments
	SECTION II				
	PRD PARA. NO.	HUMAN FACTORS REQUIREMENTS SECTION			
	6.X.12.1.1	Anthropometric Design	X	4.1	
	6.X.12.1.2	Payload Orientation	X	4.1	
	6.X.12.1.3	Color	X	4.1	
	6.X.12.1.4	Controls and Display	X	4.1	
	6.X.12.1.5	Labeling/Coding	X	4.1	
	6.X.12.1.6	Drawer/Tray Design	X	4.1	
	6.X.12.1.7	Closure/Cover Design	X	4.1	
	6.X.12.1.8	Mounting	X	4.1	
	6.X.12.1.9	Portable Item Handles/Grasp Areas	X	4.1	
	6.X.12.1.10	Payload-Unique Crew Restraints	N/A		ISS Requirement. Not directly related to WS.
	6.X.12.1.11	Payload-Unique Equipment Restraints	N/A		ISS Requirement. Not directly related to WS.
	6.X.12.1.12	Payload-Unique Handhold Positions	N/A		ISS Requirement. Not directly related to WS.
	6.X.12.1.13	Fastener Design	X	4.1	
	6.X.12.1.14	Connector Design	X	4.1	
	6.X.12.1.15	Hose/Cable Restraints	X	4.1	
	6.X.12.1.16	Packaging Design	X	4.1	
	6.X.12.1.17	Cable Management	X	4.1	
	6.X.12.1.18	Accessibility	X	4.1	
	6.X.12.1.19	Housekeeping	X	4.1	
	6.X.12.1.20	Mechanical Energy Evaluation	N/A		ISS Requirement. Not directly related to WS.
	6.X.12.1.21	Latch Status Display	N/A		ISS Requirement. Not directly related to WS.
	6.X.12.1.22	Mounting Bolt/Fastener Spacing	N/A		
	6.X.12.1.23	Hazard Levels	N/A		

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No.	Reference Document Item No.	Abbreviated Requirement Title	App.	HRD Para. No.	Comments
	SECTION III				
	STANDARD NO.	JSCM-8080 REQUIREMENTS SECTION			
	G-1	Equipment Accessibility for Maintenance	X	3.1	Systems shall be designed for removal for maintenance during ground operations.
	G-2	Separation of Redundant Equipment	N/A	N/A	No critical redundant systems.
	G-3	Systems Checkout Provisions	X	3.1	Front panel electrical connectors for access to the data networks will be provided.
	G-4	Protection of Spacecraft Electrical and Mechanical Systems from Debris	X	N/A	Debris screens and conformal coating of electronic components will be used.
	G-5	Interior Design of Spacecraft for Cleanliness	N/A	N/A	Not a spacecraft design. The cleaning requirements are in Section 4.4 of this HRD.
	G-6	Redundancy Requirements	N/A	N/A	Not flight critical items. No redundancy in design.
	G-7	Time Displays	N/A	N/A	No time displays.
	G-8	Redundant Paths - Verification of Operation	N/A	N/A	No flight critical items. No redundancy in design.
	G-9	Shatterable Material - Exclusion From Habitable Compartment	X	10.3	
	G-10	Control of Limited - Life Components	A	4.12.3	WS system batteries require life monitoring.
	G-11	Procurement Document Identification for Manned Space flight Vehicle Items	X	N/A	Inspection of Support Contractor Purchase Request.
	G-12	Application of Previous Qualification Tests	N/A	N/A	For new design no Previous Qualification Test will be applicable.
	G-13	Shipping and Handling Protection for Space flight Hardware	X	N/A	All shipments will be packaged through the JSC Shipping and Receiving organization.
	G-14	Identification and Classification of Flight and Non-flight Equipment	X	9.0	
	G-15	Equipment Failure - Verification of Flight Readiness	X	6.0	
	G-16	Operating Limits on Temperature - Controlled Equipment	X	5.2	Internal temperature monitoring and shut off.
	G-17	Separate Stock for Space flight Parts and Materials	X	N/A	All parts will be controlled through the LSPD Bonded Storage system.
	G-18	Safety Precautions - Test and Operating Procedures	X	N/A	No safety critical operations anticipated, but procedures will be prepared if the need is identified.
	G-19	Special Processes - Identification of Drawings	X	N/A	Not required for commercial-off-the-shelf hardware systems.
	G-20	Spacecraft Equipment - Protection from System	N/A	N/A	Not located in areas with potential fluid leaks.

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No.	Reference Document Item No.	Abbreviated Requirement Title	App.	HRD Para. No.	Comments
		Liquids			
	G-21	Spacecraft Equipment - Moisture Protection	X	5.4	Use of conformal coatings for all electrical printed circuit board assemblies will apply. Review drawings.
	G-22	Parts Identification	X	N/A	Parts will be identified and controlled in the LSPD Bonded Storage system.
	G-23	Pressure Garment Wiring - Ignition of Materials by Electrical Current	N/A	N/A	No pressure garment interfaces.
	G-24	Ground Support Equipment and Airborne Support Equipment Protective Devices	X	N/A	No GSE to spacecraft systems. GSE does interface to flight hardware.
	G-25	Thermal Design and Analysis - Thermal Parameters	X	5.2, 7.2.4.2, 8.2.4	Systems will be tested over the anticipated temperature ranges. No special temperature sensitive devices.
	G-26	Internally Generated Radiation	N/A	N/A	No laser systems.
	G-27	Fire Control	X	4.5.1.1	Experiment systems shall have materials certification for flammability.
	G-28	Sealing - Solid Propellant Rocket Motors	N/A	N/A	No solid rockets.
	G-29	Reentry Propulsion Subsystem In-Flight Test	N/A	N/A	No re-entry system.
	G-30	Switch Protection Devices	X	4.1	
	G-31	Detachable Crew - Operated Tools- Restriction in Spacecraft	N/A	N/A	
	G-32	Measurement Systems that Display Flight Information to the Crew - Indication of Failure	N/A	N/A	No critical flight systems.
	G-33	Surface Temperatures	X	3.1.5.5	Surface temperatures shall be less then 45°C (113°F)
	G-34	Extravehicular Activity Electronic Connectors	N/A	N/A	No EVA
	G-35	Enclosure Panels External to the Habitable Modules	N/A	N/A	No panels external to the habitable module.
	G-36	Thermal Blankets - Extravehicular Activity	N/A	N/A	No thermal blankets.
	G-37	Verification of Adequate External Visibility	N/A	N/A	No viewing requirements.
	G-38	Pressurization or Repressurization - Precluding Ingress of Undesirable Elements	N/A	N/A	No pressurization, repressurization, or ventilation systems.
	G-39	Lightning Protection Design	N/A	N/A	Not applicable to internal experiment systems.
	G-40	Radioactive Luminescent Devices	N/A	N/A	No radioactive luminescent devices are used.

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No.	Reference Document Item No.	Abbreviated Requirement Title	App.	HRD Para. No.	Comments
	G-41	Acoustic Noise Criteria	N/A	N/A	Rack level Requirement
	G-42	Solar Wind Environment	N/A	N/A	Spacelab mounted - no solar wind.
	G-43	Centralized Subsystem Controls	X	4.1	
	G-44	Attitude Control Authority	N/A	N/A	No attitude control.
	G-45	Solid Propellant Rocket Motors - Ignition Capability with Unsealed Nozzle	N/A	N/A	No solid rockets.
	G-46	Separation Sensing System - Structural Deformation	N/A	N/A	No separation sensing systems.
	G-47	Gyroscopes - Verification of Rotational Speed or Drift Rate	N/A	N/A	No gyro-scopes.
	G-48	Onboard Experiments - Required Pre-installation Checklist	X	N/A	
	G-49	Temperature and Pressure Monitoring Requirements of Hydrogen Peroxide Systems	N/A	N/A	No hydrogen peroxide systems.
	G-50	Direct Procurement of Parts	X	N/A	Certificate of compliance will be provided for all flight hardware procurements.
	G-51	Flight Hardware - Restriction on Use for Training	X	N/A	Training with flight hardware will be limited, but may be required due to number of available units.
	G-52	Reuse of Flight Hardware	X	N/A	
	ELECTRICAL				
	E-1	Mating Provisions for Electrical Connectors	X	4.1	
	E-2	Protection of Severed Electrical Circuits	N/A	N/A	Experiment and supporting systems do not use severed circuits.
	E-3	Electrical and Electronic Devices - Protection from Reverse Polarity and/or Other Improper Electrical Inputs	X	4.1	
	E-4	Electrical Connectors - Moisture Protection	X	N/A	Electronics shall be protected against moisture using shrink tubing and conformal coating.
	E-5	Electrical Connectors - Pin Assignment	N/A	N/A	Applies only if a short between adjacent pins could cause injury to the crew or degradation of a critical system.
	E-6	Corona Suppression	N/A	N/A	No high voltages.
	E-7	Tantalum Wet Slug Capacitors - Restriction on Use	X	N/A	Waived if used in commercial systems.

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HRD APPLICABILITY MATRIX (Cont'd)

No.	Reference Document Item No.	Abbreviated Requirement Title	App.	HRD Para. No.	Comments
	E-8	Electrical and Electronic Supplies and Loads - Verification Tests	X	4.14	Waived if used in commercial systems.
	E-9	Electrical Circuits - De energizing Requirements	X	N/A	No GSE systems that interface directly with the spacecraft systems.
	E-10	Cleaning of Electrical and Electronic Equipment	X	4.4	
	E-11	Protective Covers or Caps for Electrical Receptacles and Plugs	X	N/A	
	E-12	Electrical Connectors - Disconnection for Troubleshooting and Bench Testing	X	N/A	
	E-13	Bioinstrumentation Systems - Crew Electrical Shock Protection	N/A	N/A	No bioinstrumentation circuits.
	E-14	Electrical Wire Harness - Dielectric Tests	X	N/A	Applies to harnesses fabricated at JSC.
	E-15	Electrical Power Distribution Circuits - Overload Protection	X	N/A	
	E-16	Testing Protective Devices for Solid-State Circuits	N/A		Not applicable for commercial off-the-shelf hardware systems. No safety critical circuits.
	E-17	Electrical and Electronic Piece Parts - Closure Construction	X	N/A	Sealed components or conformal coating shall be used.
	E-18	Circuitry for Automatic Shutdown of Launch Vehicle Engine(s)	N/A	N/A	No engines.
	E-19	Equipment Design - Power Transients	N/A	N/A	Rack level requirement
	E-20	Control of Electrostatic Discharge for Electronic Parts and Assemblies	N/A	N/A	Not applicable to Class C payloads.
	E-21	Electrical Connectors	X	N/A	Not applicable to off-the-shelf hardware.
	E-22	Ionizing Radiation Effects	X	5.10	Not applicable to off-the-shelf hardware.
	E-23	Transistors - Selection of Types	X	N/A	Not applicable to off-the-shelf hardware.
	E-24	Electrical Wire and Cable Acceptance Tests	X	N/A	The requirement is waived for commercial-off-the-shelf hardware.
	FLUIDS				
	F-1	Flow Restriction Requirements - Pressurized Sources	N/A	N/A	No pressurized systems.
	F-2	Moisture Separators in a Zero-Gravity Environment	N/A	N/A	No water separator devices.
	F-3	Service Points - Positive Protection from	N/A	N/A	No spacecraft fluid systems.

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No.	Reference Document Item No.	Abbreviated Requirement Title	App.	HRD Para. No.	Comments
		Interchangeability of Fluid Service Lines			
	F-4	Ground Service Points - Fluid Systems	N/A	N/A	No externally accessed fluid systems.
	F-5	Fluid Lines - Separation Provisions	N/A	N/A	No fluid lines that are severed during spacecraft separation.
	F-6	Temperature and Pressure Monitoring Requirements for Potentially Hazardous Reactive Fluids	N/A	N/A	No reactive fluids.
	F-7	Capping of Servicing and Test Ports	N/A	N/A	No fluid or gas systems.
	F-8	Fluid System Components Whose Function is Dependent on Direction of Flow - Protection Against Incorrect Installation	N/A	N/A	No fluid or gas systems.
	F-9	Spacecraft Venting - Induced Perturbing Forces	N/A	N/A	No venting systems.
	F-10	Nozzles and Vents - Protection Prior to Launch	N/A	N/A	No vents or nozzles.
	F-11	Fluid Supplies - Verification Tests	N/A	N/A	No spacecraft servicing fluid systems.
	F-12	Protection of Pressurized Systems from Damage Due to Pressurant Depletion - Ground Support Equipment and Airborne Support Equipment	N/A	N/A	No spacecraft servicing GSE with pressure systems.
	F-13	Crew Cabin Module Pressure - Venting Restriction	N/A	N/A	No crew cabin venting mechanisms.
	F-14	Crew Cabin Module Ventilating Fans - Protection from Debris	N/A	N/A	No crew cabin ventilating fans. The internal fans of the WS have protective screens 4 mm wide.
	F-15	Separation of Hypergolic Reactants	N/A	N/A	No hypergolic reactants.
	F-16	Fluid Line Installation	N/A	N/A	No fluid systems.
	F-17	Cleanliness of Flowing Fluids and Associated Systems	N/A	N/A	No spacecraft fluid systems.
	F-18	Pressure Relief Valves - Standardization of Functional Testing	N/A	N/A	No pressure systems.
	F-19	Protection for Tubing, Fittings, and Fluid System Components - Flight Hardware and Associated Equipment	N/A	N/A	No pressure systems.
	F-20	Fluid Systems - Cleanliness	N/A	N/A	No fluid systems.
	F-21	Purge Gases - Temperature and Humidity Requirements	N/A	N/A	No purge gases used.
	F-22	Pressure Garments - Protection Against Failure Propagation	N/A	N/A	No pressure garment pressurization systems.

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No.	Reference Document Item No.	Abbreviated Requirement Title	App.	HRD Para. No.	Comments
	F-23	Qualification Fluid	N/A	N/A	No fluid systems.
	F-24	Fluid Systems - Design for Flushing and Draining	N/A	N/A	No fluid systems.
	F-25	Toxicity - Fluids Contained in Systems in the Crew Compartment	N/A	N/A	No fluid systems.
	F-26	Atmospheric Pressure and Composition Control	N/A	N/A	No atmospheric control systems.
	F-27	Liquid or Gas Containers - Verification of Contents	N/A	N/A	No gas or fluid systems.
	F-28	Use of Halogen Method for Coolant System Leak Detection	N/A	N/A	No pressure systems.
	F-29	Filter Protection of Active Fluid Components	N/A	N/A	No fluid systems.
	F-30	Pressure Relief for Pressure Vessels	N/A	N/A	No pressure systems.
	MATERIALS AND PROCESSES				
	M/P-1	Material Selection, Review, and Drawing Sign-off	X	N/A	Not required for commercial-off-the-shelf hardware subsystems.
	M/P-2	Flammability of Wiring Material	X	4.5.1	
	M/P-3	Toxicity of Materials Used in Crew Compartments - Wire Insulation, Ties, Identification Marks, and Protective Coverings	X	4.5.1	
	M/P-4	Metals and Metal Couples-Restriction on Use	X	4.5.1	Not required for commercial-off-the-shelf hardware systems.
	M/P-5	Solutions which contain Ethylene Glycol - Requirements for Silver Chelating Agent	N/A	N/A	No Ethylene Glycol systems.
	M/P-6	Toxicity-Requirements for Nonmetallic Materials Proposed for Use within Crew Compartment	X	4.5.1	Offgas testing shall be performed on HRF WS system.
	M/P-7	Material Detrimental to Electrical Connectors	X	N/A	
	M/P-8	Leak Detectors - Wetting Agents	N/A	N/A	No pressure systems that require leak testing.

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No.	Reference Document Item No.	Abbreviated Requirement Title	App.	HRD Para. No.	Comments
	M/P-9	Breathing Systems - Requirement to Test for Mercury Contamination	N/A	N/A	No breathing systems.
	M/P-10	Liquid Locking Compounds, Restrictions, and Controls	X	N/A	
	M/P-11	Pressure Vessel Design	N/A	N/A	No pressure systems.
	M/P-12	Multi-layer Blanket Bake-Out	N/A	N/A	No thermal blankets.
	M/P-13	Pressure Vessel Design	N/A	N/A	No pressure systems.
	M/P-14	Silicate Ester Coolant System Design	N/A	N/A	No liquid cooling systems.
	M/P-15	Mercury - Restriction on Use	N/A	N/A	No Mercury is used.
	M/P-16	Restriction on Coatings for Areas Subject to Abrasion	X	N/A	
	M/P-17	Radiographic Inspection of Brazed and Welded Tubing Joints	N/A	N/A	No brazing or welding.
	M/P-18	Etching Fluorocarbon Insulated Electrical Wire	N/A	N/A	No Etching in the system.
	M/P-19	Spacecraft Material - Restriction on Use of Polyvinyl Chloride	X	4.5.1	
	M/P-20	Titanium or Its Alloys - Prohibited Use with Oxygen	N/A	N/A	No Titanium in the system.
	M/P-21	Beryllium - Restricted Use within Crew Components	X	4.5.1.1	
	M/P-22	Brazed Joints - Identification Marks	N/A	N/A	No spacecraft fuel or oxidizer lines.
	M/P-23	Pressure Vessels - Materials Compatibility and Vessel Qualifications Tests	N/A	N/A	No pressure vessels.
	M/P-24	Cadmium - Restriction on Use	N/A	N/A	Normal operating environment is pressurized and below temperature specified.
	M/P-25	Pressure Vessels - Nondestructive Evaluation Plan	N/A	N/A	No pressure vessels
	M/P-26	Repair of Sandwich - Type Structures	N/A	N/A	No sandwich-type structures are in the system.
	MECHANICAL AND STRUCTURAL				
	M/S-1	Equipment Containers - Design for Rapid Spacecraft Decompression	X	5.3	
	M/S-2	Alignment of Mechanical Systems	N/A	N/A	No special alignment requirements.

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HRD APPLICABILITY MATRIX (Cont'd)

No.	Reference Document Item No.	Abbreviated Requirement Title	App.	HRD Para. No.	Comments
	M/S-3	Wire Bundles - Protective Coating	X	N/A	Inspection of harnesses by Quality will identify any stress areas.
	M/S-4	Hatches - Repeated Use	N/A	N/A	No hatches.
	M/S-5	Threaded Fittings - Restrictions on Release of Particles and Foreign Material	X	N/A	
	M/S-6	Exposed Sharp Surfaces or Protrusions	X	N/A	
	M/S-7	Windows and Glass Structure	N/A	N/A	No spacecraft structural windows or glass.
	M/S-8	Penetration of Inhabited Spacecraft Compartments	N/A	N/A	No ingress/egress access hatches.
	M/S-9	Mechanisms	N/A	N/A	No docking, berthing, or positioning systems.
	M/S-10	Functional Doors that Operate in Flight	N/A	N/A	No critical systems with doors.
	M/S-11	Meteoroid Protection Levels for Structures	N/A	N/A	Spacelab equipment. No meteoroid environment.
	M/S-12	Spacecraft Recovery Hoist Loops	N/A	N/A	No recovery loops.
	M/S-13	Lifting and Hoisting Ground Support Equipment Identification	N/A	N/A	No spacecraft recovery hoist systems.
	M/S-14	Structural Analysis	X	N/A	
	M/S-15	Stainless Steel Tubing - Method of Joining	N/A	N/A	No stainless steel tubing in the HRF WS design.
	M/S-16	Pressure Vessels - Negative Pressure Damage	N/A	N/A	No pressure vessels.
	PYROTECHNICS				
	P-1	Explosive Devices - Arming and Disarming	N/A	N/A	No Explosive devices
	P-2	Pyrotechnic Devices - Preflight Verification Tests at Launch Sites	N/A	N/A	No pyros.
	P-3	Wire Splicing	N/A	N/A	No pyrocircuits.
	P-4	Explosive Devices - Packaging Material	N/A	N/A	No explosive devices.
	P-5	Explosive Devices - Identification Requirements	N/A	N/A	No explosive devices.
	P-6	Protection of Electrical Circuitry for Explosive Devices Employing Hot Bridge wire Initiators	N/A	N/A	No pyrotechnic devices.
	P-7	Explosive Devices - Color Coding Requirements	N/A	N/A	No explosive devices.

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APPENDIX B

HRF WORKSTATION CERTIFICATION MATRIX

	CERTIFICATION METHODS	ACCEPTANCE PROCEDURES		QUALIFICATION PROCEDURES				
T	:Test	PDA : Pre-delivery Acceptance		LT : Load Test		QTT : Qualification Thermal Test		
A	:Analysis	PIA : Pre-installation Acceptance		SA : Stress Analysis		QVT : Qualification Vibration Test		
I	: Inspection	ATT : Acceptance Thermal Test		F/C : Fit-Check		QAVT : Qualification Acceptance Vib. Test		
S	: Similarity	AVT : Acceptance Vibration Test		FT : Functional Test		QSWTP : Qual. Software Test Procedure		
D	: Demonstration	F/C : Fit-Check						

Paragraph No.	REQUIREMENT	ACCEPT. Method	ACCEPT. Procedure	QUAL. Method	QUAL. Procedure	VERIFICATION DOCUMENT	(O) (X)	COMMENTS / HARDWARE CONFIGURATION
3.0	UNIQUE DESIGN REQUIREMENTS							Hardware Specific, template does not apply.
3.1	HRF Workstation							
3.1.1	Description							
3.1.1.1	HRF Workstation Computer Drawer							
3.1.1.2	HRF WS Keyboard							
3.1.1.3	HRF Flat Screen Display							
3.1.1.4	HRF WS Archive Media							
3.1.1.5	HRF WS Cables							
3.1.2	PERFORMANCE REQUIREMENTS							
3.1.2.1	HRF WS Computer Drawer							
3.1.2.1.1	Min. 200 MHz Pentium	T	PDA	T	PDA		O	Inspect part number. Upon system boot-up, the processor clock speed indicated on monitor shall read 200 Mhz. or greater.
3.1.2.1.2	Min. 256 Kbyte cache and128 Mbyte main memory	I, T	PDA	I, T	PDA		O	Inspect part number. Upon system boot-up, the memory size indicated on monitor shall read 256 K RAM and 128 M main memory, minimum.
3.1.2.1.3	Min. 8 channel A/D (12bits), 8 channel D/A (12bits) with 48 KHz sampling rate, audio compression/decompression capability	I, T	PDA	I, T	PDA		O	Inspect part number. Test each channel to verify that a minimum sampling rate of 48 Khz is achievable.
3.1.2.1.4	Color stereo video to Head Mounted display	I, T	PDA	I, T	PDA		O	Inspect design. Connect to the VEG Head-Mounted Display to verify that the system drives the VEG HMD.
3.1.2.1.5	Alpha-numeric display support	T	PDA	T	PDA		O	Connect to display to verify that the system drives the display.
3.1.2.1.6	QWERTY keyboard input support; display and keyboard setup in less than 5 minutes	T	PDA	T	PDA		O	Connect to QWERTY keyboard. Verify that set up time is less than 5 minutes. Characters on display matches keyboard input.
3.1.2.1.7	Two 115.2 Kbps RS-422 lines	I, T	PDA	I, T	PDA		O	Inspect part number. Test each channel to verify that the system is capable of 115.2 Kbps
3.1.2.1.8	In-flight archive removal and replacement without tools	T	PDA	T	PDA		O	Remove and replace archive media to verify that no tools are needed for the procedure.
3.1.2.1.9	Thermal protection	I, T	PDA	I, T	PDA		O	Inspect design. Test to verify that system shuts down when the internal temperature limit of 45 degrees Celsius is exceeded.
3.1.2.1.10	EMI/RFI protection at vents, connectors, and drawer joints	I	PDA	I	PDA		O	Inspect to verify existence of EMI/RFI gaskets and filters. Inspect design.
3.1.2.1.11	Min. 2 continuous hours of 256 Kbps archive	T	PDA	T	PDA		O	Test to verify. See 3.1.2.1.11of this WS HRD.
3.1.2.1.12	Archival media upgrade possible without hardware configuration change	I	PDA	I	PDA		O	Inspect design to verify that media upgrade is possible without hardware configuration change
3.1.2.1.13	8,000 bps speech digitizing/compression	I, T	PDA	I, T	PDA		O	Inspect part number. Have the system compress speech to verify that a minimum compression/digitization rate of 8 Kbps or lower is achievable.
3.1.2.1.14	Ethernet compatible with EXPRESS Rack available	I, T	PDA	T	PDA		O	Inspect design. Test Ethernet functionality.
3.1.2.1.15	Printer Interface Support	T	PDA	T	PDA		O	Connect to printer to verify that system can print.
3.1.2.1.16	Capable of generating a minimum of 60,000 triangles per sec., 24-bit color, 1280 x 1024	I	PDA	I	PDA		O	Inspect part number.
3.1.2.2	HRF Flat Screen Keyboard							
3.1.2.2.1	Standard QWERTY input.	T	PDA	T	PDA		O	Connect to known functional system to verify QWERTY functionality.

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CERTIFICATION METHODS		ACCEPTANCE PROCEDURES		QUALIFICATION PROCEDURES		
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D	: Demonstration	F/C	: Fit-Check			

Paragraph No.	REQUIREMENT	ACCEPT. Method	ACCEPT. Procedure	QUAL. Method	QUAL. Procedure	VERIFICATION DOCUMENT	(O) (X)	COMMENTS / HARDWARE CONFIGURATION
3.1.2.2.2	Attachable to EXPRESS Rack seat track and be adjustable	T	PDA	T	PDA		O	Test to verify that keyboard attaches to EXPRESS Rack seat track and is adjustable, dependant on PCS mounting bracket.
3.1.2.2.3	Cursor Controller Support	T	PDA	T	PDA		O	Connect to cursor controller to verify functionality.
3.1.2.2.4	Will be Stowed in HRF Rack	I	PDA	I	PDA		O	
3.1.2.2.5	Will receive power from HRF WS Computer Drawer	I,T	PDA	I,T	PDA		O	Inspect design. Connect to HRF WS Computer Drawer to verify functionality.
3.1.2.3	HRF WS Display							
3.1.2.3.1	Attachable to EXPRESS Rack seat track and be adjustable	T	PDA	T	PDA		O	Test to verify that display attaches to EXPRESS Rack seat track and is adjustable, dependent on PCS mounting bracket.
3.1.2.3.2	Min. 1024 x 1280 resolution, 24-bit color	T	PDA	T	PDA		O	Connect to known functional system configured for 1024x1280 resolution, 24-bit color to verify that display is functional.
3.1.2.3.3	Display area comparable to that of a 17" monitor.	I	PDA	I	PDA		O	Display a document/pattern on a 17" monitor and on HRF Flat Screen Display to verify that viewing areas are comparable. Current design is 16.1" diagonal.
3.1.2.3.4	Will be Stowed in HRF Rack	I	PDA	I	PDA		O	
3.1.2.3.5	Will receive power from HRF WS Computer Drawer	I,T	PDA	I,T	PDA		O	Inspect design. Connect to HRF WS Computer Drawer to verify functionality.
3.1.2.4	HRF WS Archive Media							
3.1.2.4.1	Min. 2 continuous hours of 256 Kbps archive	T	PDA	T	PDA		O	SEE 3.1.2.1.11 of this matrix
3.1.2.4.2	Upgradeable without system configuration change.	I	PDA	I	PDA		O	SEE 3.1.2.1.12 of this matrix
3.1.2.4.3	Compatible with SCSI Linear Insertion Mechanical Enclosure	T	PDA	T	PDA		O	Insert in HRF WS SCSI LIME and test for fit and functionality.
3.1.2.4.4	PCMCIA capacity of 340 Mbytes and SCSI HDD capacity of 2.1 Gbytes minimum.	I	PDA	I	PDA		O	Inspect part number.
3.1.2.5	HRF WS Cables							
3.1.2.5.1	Keyboard Cable	T	PDA	T	PDA		O	Verify functionality
3.1.2.5.2	Display Cable	T	PDA	T	PDA		O	Verify functionality
3.1.3	LIMIT LOAD REQUIREMENTS	N/A		A	See Comment		O	SA for Rack, Assessment for Stowed
3.1.3.1	Launch/Landing	N/A		A	See Comment		O	SA for Rack, Assessment for Stowed
3.1.3.2	Crew Induced Loads	N/A		A	See Comment		O	SA for Rack, Assessment for Stowed
3.1.3.3	Pressure Systems	N/A		N/A				
3.1.4	PHYSICAL REQUIREMENTS							
3.1.4.1	Mass (Weight)							
3.1.4.1.1	HRF WS Computer Drawer is maximum 80 lbs. (36 kg)	T	PDA	T	PDA		O	Weigh to verify weight is 80 lbs. or less.
3.1.4.1.2	HRF WS Keyboard is maximum 9 lbs. (4 kg)	I	PDA	I	PDA		O	Weigh to verify weight is 9 lbs. or less.
3.1.4.1.3	HRF Flat Screen Display is maximum 20 lbs. (9 kg)	I	PDA	I	PDA		O	Weigh to verify weight is 15 lbs. or less.
3.1.4.1.4	HRF WS Cables are a maximum of 15 lbs (6.8 kg)	I	PDA	I	PDA		O	
3.1.4.2	Envelope							
3.1.4.2.1	HRF WS Computer Drawer is 4 PU	I	PDA	I	PDA		O	Inspect drawings.
3.1.4.2.2	HRF WS Keyboard volume is max of 18 x 10 x 2.5 in. (46 x 26 x 7 cm)	I	PDA	I	PDA		O	Measure to verify.
3.1.4.2.3	HRF Flat Screen Display volume is max of 16 x 14 x 6 in. (41 x 36 x16 cm)	I	PDA	I	PDA		O	Measure to verify.
3.1.4.2.4	HRF WS Media volume is max of 4 x 2.5 x 0.5 in. (10 x 7 x 2 cm) for PCMCIA type and max 1.5 x 6 x 5 in. (4 x 16 x 8 cm) for SCSI type.	I	PDA	I	PDA		O	Measure to verify.
3.1.4.2.5	HRF WS Cables volume is max 75 in^3 per cable	I	PDA	I	PDA			Measure to verify.

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	I	: Inspection	ATT : Acceptance Thermal Test		F/C : Fit-Check	QAVT : Qualification Acceptance Vib. Test		
	S	: Similarity	AVT : Acceptance Vibration Test		FT : Functional Test	QSWTP : Qual. Software Test Procedure		
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3.1.4.3	Center of Gravity			T	See Comment		O	C.G. will be tested for integrated stowage drawer for Qual.
3.1.5	INTERFACE REQUIREMENTS							
3.1.5.1	STRUCTURAL MECHANICAL INTERFACE REQUIREMENTS							
3.1.5.2	ELECTRICAL INTERFACE REQUIREMENTS							
3.1.5.2.1	HRF WS to Rack per HRF PRD Section 6.2.2	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.2.2	HRF WS to Other Payloads	T	PDA	T	PDA		O	
3.1.5.3	COMMUNICATION AND DATA HANDLING INTERFACE REQUIREMENTS							
3.1.5.3.1	HRF WS to Rack HRF PRD Section 6.2.3 RS-422, IEEE 802.3, and GMT	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2	HRF WS to Other Payloads	T	PDA	T	PDA			
3.1.5.3.2a	RGB, 2 channels out, 1 in	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2b	Analog to Digital interface	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2c	Digital to Analog interface	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2d	Digital Input/Output	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2e	Floppy Drive interface	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2f	Parallel interface	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2g	NTSC/RS-170 video interface	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2h	IRIG-B interface	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2i	Audio interface	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2j	Three Serial Com interfaces	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2k	VGA and Keyboard interfaces	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2l	Ethernet interface	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.3.2m	SCSI interface	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.4	AUDIO VISUAL INTERFACE REQUIREMENTS							
3.1.5.4.1	HRF WS to Rack per HRF PRD Section 6.2.4.1.2	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.4.2	HRF WS to Other Payloads	T	PDA	T	PDA		O	Test to HRF WS Interface Definition Document
3.1.5.5	THERMAL CONTROL INTERFACE REQUIREMENTS							
3.1.5.5.1.1	General Requirements							
3.1.5.5.2	HRF Rock Common Fan							
3.1.5.5.2.1	IVA Replaceable							
3.1.5.5.2.2	Vibration/Acoustic Isolated	T	PDA	T	PDA		O	Perform thermal analysis to verify
3.1.5.6	WASTE GAS VENT AND VACUUM INTERFACE REQUIREMENT	N/A		N/A				
3.1.5.7	NITROGEN INTERFACE REQUIREMENT	N/A		N/A				
3.1.6	SOFTWARE DESIGN							
3.1.6.1	Definitions							
3.1.6.2	Operating System	N/A		D	QSWTP		O	Demonstrate capabilities. Specific tests on a version basis defined in test plan.

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3.1.6.3	User Interface	N/A		D	QSWTP		O	Demonstrate capabilities. Specific tests on a version basis defined in test plan. Hardware unit certification/verification does not require verification of this CSCI.
3.1.6.4	Test Software	N/A		D	QSWTP		O	Demonstrate capabilities. Specific tests on a version basis defined in test plan.
3.1.6.5	Training Software	N/A		D	QSWTP		O	Demonstrate capabilities. Specific tests on a version basis defined in test plan. Hardware unit certification/verification does not require verification of this CSCI.
3.1.6.6	Office Software	N/A		D	QSWTP		O	Demonstrate capabilities. Specific tests on a version basis defined in test plan. Hardware unit certification/verification does not require verification of this CSCI.
3.1.6.7	Lab Software	N/A		D	QSWTP		O	Demonstrate capabilities. Specific tests on a version basis defined in test plan. Hardware unit certification/verification does not require verification of this CSCI.
3.1.6.8	Engineering Software	N/A		D	QSWTP		O	Demonstrate capabilities. Specific tests on a version basis defined in test plan. Hardware unit certification/verification does not require verification of this CSCI.
3.1.6.9	Flight Support Software	N/A		D	QSWTP		O	Demonstrate capabilities. Specific tests on a version basis defined in test plan. Hardware unit certification/verification does not require verification of this CSCI.
3.1.6.10	Ground Software	N/A		D	QSWTP		O	Demonstrate capabilities. Specific tests on a version basis defined in test plan.
4.0	GENERAL DESIGN REQUIREMENTS							
4.1	HUMAN FACTORS							
4.1.a	HRF WS supports visual display	T	PDA	T	PDA		O	See Section 3.1.2.1.5 of this matrix
4.1.b	HRF WS supports keyboard for alphanumeric and text input	T	PDA	T	PDA		O	See Section 3.1.2.1.6 of this matrix
4.1.c	HRF WS Supports a cursor control device	T	PDA	T	PDA		O	Connect to a cursor control device to verify that cursor control is possible.
4.1-1	Anthropometric Design	N/A		I	PDA		O	Inspection of drawings and hardware.
4.1-2	Payload Orientation	N/A		I	PDA		O	Inspection of drawings and hardware.
4.1-3	Color	N/A		I	PDA		O	Inspection of drawings and hardware.
4.1-4	Controls and Display	N/A		I	PDA		O	Inspection of drawings and hardware.
4.1-5	Labeling/Coding	N/A		I	PDA		O	Inspection of drawings and hardware.
4.1-6	Drawer/Tray Design	N/A		I	PDA		O	Inspection of drawings and hardware.
4.1-7	Closure/Cover Design	N/A		I	PDA		O	Inspection of drawings and hardware.
4.1-8	Mounting	N/A		I	PDA		O	Inspection of drawings and hardware.
4.1-9	Portable Item Handles/Grasp Areas	N/A		I	PDA		O	Inspection of drawings and hardware.
4.1-10	Payload-Unique Crew Restraints	N/A		N/A	PDA		O	
4.1-11	Payload-Unique Equipment Restrains	N/A		N/A				
4.1-12	Payload-Unique Handhold Positions	N/A		N/A	FT		O	
4.1-13	Fastener Design	I	PDA	I	FT		O	Inspection of drawings and hardware
4.1-14	Connector Design	I	PDA	I, T	FT		O	Inspection of drawings and hardware
4.1-15	Hose/Cable Restraints	I	See Comment	I	FT		O	As Needed.
4.1-16	Packaging Design	I		I	FT		O	Inspection of drawings and hardware
4.1-17	Cable Management	I	See Comment	I, T	FT		O	As Needed.
4.1-18	Accessibility	I		I	PDA		O	Inspection of drawings and hardware
4.1-19	Housekeeping	I		I	PDA		O	Inspection of drawings and hardware
4.1-20	Mechanical Energy Evaluation	N/A						
4.1-21	Latch Status Display	N/A						
4.1-22	Mounting Bolt/Fastener Spacing	N/A		N/A				
4.1-23	Hazard Labels	NA		N/A				

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4.2	MANNED SPACECRAFT CRITERIA and STANDARDS (JSCM-8080s)							
4.2.G-1	Equipment Access. for Maint.	N/A		I	PDA		O	Inspect drawings, design, and hardware
4.2.G-2	Separation of Redundant Equip.	N/A		N/A	See Comment		O	Ref. Hardware Item FMEA/CIL
4.2.G-3	Systems Checkout Provisions	N/A		I	PDA		O	Inspect drawings, design, and hardware
4.2.G-4	Protection of Spacecraft Elect. and Mech. Systems from Debris	N/A		I	See Comment		O	Inspect drawings and design
4.2.G-5	Interior Design of Spacecraft for Cleanliness	N/A		N/A				See HRD, Para. 4.4
4.2.G-6	Redundancy Requirements	N/A		N/A			O	Not critical to flight subsystem
4.2.G-7	Time Displays	N/A		N/A				
4.2.G-8	Redundant Paths - Verification of Operation	N/A		N/A			O	Not critical to flight subsystem
4.2.G-9	Shatterable Material - Exclusion From Habitable Compartment	N/A		I, A	PDA		O	Inspect HW Item drawings and design
4.2.G-10	Control of Limited - Life Components	A		A				See HRD, Para. 4.12.3
4.2.G-11	Procurement Document Identification for Manned Space flight Vehicle Items	I	See Comment	N/A			O	Audit SCPRs as necessary
4.2.G-12	Application of Previous Qualification Tests	N/A		N/A				
4.2.G-13	Shipping and Handling Protection for Space flight Hardware	I	PDA	N/A			O	See Appendix A.
4.2.G-14	Identification and Classification of Flight and Non-flight Equipment	I	PDA	N/A			O	Inspect drawings.
4.2.G-15	Equipment Failure - Verification of Flight Readiness	A	See Comment	N/A			O	DR and FIAR system in-place
4.2.G-16	Operating Limits on Temperature - Controlled Equipment	N/A		A, T	See Comment		O	Ref. HRD, Para. 5.2
4.2.G-17	Separate Stock for Space flight Parts and Materials	I	See Comment	N/A			O	Ref. assembly TPS and acceptance data pack (ADP)
4.2.G-18	Safety Precautions - Test and Operating Procedures	I	See Comment	I	See Comment		O	Audit Test Procedures
4.2.G-19	Special Processes - Identification of Drawings	N/A		I	See Comment		O	Review drawings
4.2.G-20	Spacecraft Equipment - Protection from System Liquids	N/A		N/A				Not applicable to HW Item design
4.2.G-21	Spacecraft Equipment - Moisture Protection	N/A		A, T	See Comment		O	Ref. HRD, Para. 5.4
4.2.G-22	Parts Identification	I	PDA	I	see PDA		O	Ref. assembly TPS and acceptance data pack (ADP)
4.2.G-23	Pressure Garment Wiring - Ignition of Materials by Electrical Current	N/A		N/A				Not applicable to HW Item design
4.2.G-24	GSE and ASE Protective Devices	I	See Comment	I	See Comment		O	Review GSE design and/or drawings
4.2.G-25	Thermal Design and Analysis - Thermal Parameters	N/A		A, T	See Comment		O	Ref. HRD, Para. 5.2
4.2.G-26	Internally Generated Radiation	N/A		N/A				
4.2.G-27	Fire Control	N/A		T				Ref. HRD, Para. 4.5.1.1
4.2.G-28	Sealing - Solid Propellant Rocket Motors	N/A		N/A				Not applicable to HW Item design
4.2.G-29	Reentry Propulsion Subsystem In- Flight Test	N/A		N/A				Not applicable to HW Item design
4.2.G-30	Switch Protection Devices	N/A		D	PDA		O	
4.2.G-31	Detachable Crew-Operated Tools - Restriction in Spacecraft	N/A		N/A				Not applicable to HW Item design
4.2.G-32	Measurement Systems that Display Flight Information to the Crew - Indication of Failure	N/A		N/A				Not applicable to HW Item design
4.2.G-33	Surface Temperatures	N/A		A, T	See Comment		O	
4.2.G-34	Extravehicular Activity Electronic Connectors	N/A		N/A				Not applicable to HW Item design
4.2.G-35	Enclosure Panels External to the Habitable Modules	N/A		N/A				Not applicable to HW Item design
4.2.G-36	Thermal Blankets - Extravehicular Activity	N/A		N/A				Not applicable to HW Item design

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4.2.G-37	Verification of Adequate External Visibility	N/A		N/A				No EVA functions
4.2.G-38	Pressurization or Repressurization - Precluding Ingress of Undesirable Elements	N/A		N/A				Not applicable to HW Item design
4.2.G-39	Lightning Protection Design	N/A		N/A				Not applicable to HW Item design
4.2.G-40	Radioactive Luminescent Devices	N/A		N/A				Not applicable to HW Item design
4.2.G-41	Acoustic Noise Criteria	N/A		A	See Comment		O	Rack Level Requirement
4.2.G-42	Solar Wind Environment	N/A		N/A			O	HW will operate in a lower environment
4.2.G-43	Centralized Subsystem Controls	N/A		I				Drawing inspection
4.2.G-44	Attitude Control Authority	N/A		N/A				Not applicable to HW Item design
4.2.G-45	Solid Propellant Rocket Motors - Ignition Capability with Unsealed Nozzle	N/A		N/A				Not applicable to HW Item design
4.2.G-46	Separation Sensing System - Structural Deformation	N/A		N/A				Not applicable to HW Item design
4.2.G-47	Gyroscopes - Verification of Rotational Speed or Drift Rate	N/A		N/A				Not applicable to HW Item design
4.2.G-48	Onboard Experiments - Required Pre-installation Checklist	N/A		A	See Comment		O	Rev. FMEA/CIL, SAR, crew training
4.2.G-49	Temp. and Press. Monitoring Rqmts of Hydrogen Peroxide Systems	N/A		N/A				Not applicable to HW Item design
4.2.G-50	Direct Procurement of Parts	I	See Comment	N/A			O	Audit SCPRs and SOWs
4.2.G-51	Flt HW - Restriction on Use for Training	I	See Comment	I	See Comment		O	Controlled by TPS
4.2.G-52	Reuse of Flight Hardware	A, I, T	FT	N/A			O	Controlled by TPS
4.2.E-1	Mating Provisions for Electrical Connectors	N/A		I	See Comment		O	Review HW Item design and drawings
4.2.E-2	Protection of Severed Electrical Circuits	N/A		N/A				Not applicable to HW Item design
4.2.E-3	Electrical and Electronic Devices - Protection from Reverse Polarity and/or Other Improper Electrical Inputs	N/A		I, T	See Comment		O	Review HW Item design and drawings
4.2.E-4	Electrical Connectors - Moisture Protection	N/A		I	See Comment		O	Review HW Item design and drawings
4.2.E-5	Electrical Connectors - Pin Assignment	N/A		I	See Comment		O	Review HW Item design and drawings
4.2.E-6	Corona Suppression	N/A		N/A				Not applicable to HW Item design
4.2.E-7	Tantalum Wet Slug Capacitors - Restriction on Use	N/A		I	See Comment		O	Review HW Item design and drawings
4.2.E-8	Electrical and Electronic Supplies and Loads - Verification Tests	I	See Comment	T	See Comment		O	Review TPSs
4.2.E-9	Electrical Circuits - De energizing Requirements	N/A		I	See Comment		O	Review drawings, design, and training procedures
4.2.E-10	Cleaning of Electrical and Electronic Equipment	I	PDA	I	See Comment		O	Review drawings, design, PDA, and data pack
4.2.E-11	Protective Covers or Caps for Electrical Receptacles and Plugs	I	See Comment	I	See Comment		O	Review Flt. HW and GSE drawings and design
4.2.E-12	Electrical Connect. - Disconnect. for Troubleshoot. and Bench Testing	I	See Comment	I	See Comment		O	Controlled by TPS and operation procedures
4.2.E-13	Bioinstrumentation Systems - Crew Electrical Shock Protection	N/A		N/A				
4.2.E-14	Electrical Wire Harness - Dielectric Tests	T	PDA	N/A			O	Ref. assembly TPS and acceptance data pack (ADP)
4.2.E-15	Electrical Power Distribution Circuits - Overload Protection	N/A		I	See Comment		O	Review HW Item design and drawings
4.2.E-16	Testing Protective Devices for Solid-State Circuits	N/A	N/A	NA				
4.2.E-17	Electrical and Electronic Piece Parts - Closure Construction	N/A		I	See Comment		O	Review HW Item design and drawings
4.2.E-18	Circuitry for Automatic Shutdown of Launch Vehicle Engine(s)	N/A		N/A				Not applicable to HW Item design
4.2.E-19	Equipment Design - Power Transients	N/A		N/A	See Comment			Evaluation will be run. Transient is rack level req.

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4.2.E-20	Control of Electrostatic Discharge for Electronic Parts and Assemblies	N/A		N/A				Not applicable to HW Item design
4.2.E-21	Electrical Connectors	N/A		I, D	PDA		O	
4.2.E-22	Ionizing Radiation Effects	N/A		N/A				Ref. HRD Par. 5.10
4.2.E-23	Transistors - Selection of Types	N/A		I			O	Review HW Item design and drawings
4.2.E-24	Electrical Wire and Cable Acceptance Tests	A, I	PDA	N/A			O	Ref. assembly TPS and acceptance data pack (ADP)
4.2.F-1	Flow Restriction Requirements - Pressurized Sources	N/A		N/A				
4.2.F-2	Moisture Separators in a Zero-Gravity Environment	N/A		N/A				Not applicable to HW Item design
4.2.F-3	Service Points - Positive Protection from Interchangeability of Fluid Service Lines	N/A		N/A				
4.2.F-4	Ground Service Points - Fluid Systems	N/A		N/A				
4.2.F-5	Fluid Lines - Separation Provisions	N/A		N/A				Not applicable to HW Item design
4.2.F-6	Temperature and Pressure Monitoring Requirements for Potentially Hazardous Reactive Fluids	N/A		N/A				Not applicable to HW Item design
4.2.F-7	Capping of Servicing and Test Ports	N/A		N/A				
4.2.F-8	Fluid System Components Whose Function is Dependent on Direction of Flow - Protection Against Incorrect Installation	N/A		N/A				
4.2.F-9	Spacecraft Venting - Induced Perturbing Forces	N/A		N/A				Not applicable to HW Item design
4.2.F-10	Nozzles and Vents - Protection Prior to Launch	N/A		N/A				Not applicable to HW Item design
4.2.F-11	Fluid Supplies - Verification Tests	N/A		N/A				Not applicable to HW Item design
4.2.F-12	Protection of Pressurized Systems from Damage Due to Pressurant Depletion - Ground Support Equipment and Airborne Support Equipment	N/A		N/A				Not applicable to HW Item design
4.2.F-13	Crew Cabin Module Pressure - Venting Restriction	N/A		N/A				Not applicable to HW Item design
4.2.F-14	Crew Cabin Module Ventilating Fans - Protection from Debris	N/A		N/A				GASMAP only, Ref. HRD Para. 4.5.1.3
4.2.F-15	Separation of Hypergolic Reactants	N/A		N/A				Not applicable to HW Item design
4.2.F-16	Fluid Line Installation	N/A		N/A				Not applicable to HW Item design
4.2.F-17	Cleanliness of Flowing Fluids and Associated Systems	N/A		N/A				
4.2.F-18	Pressure Relief Valves - Standardization of Functional Testing	N/A		N/A				Not applicable to HW Item design
4.2.F-19	Protection for Tubing, Fittings, and Fluid System Components - Flight Hardware and Associated Equipment	N/A		N/A				
4.2.F-20	Fluid Systems - Cleanliness	N/A		N/A				
4.2.F-21	Purge Gases - Temperature and Humidity Requirements	N/A		N/A				Not applicable to HW Item design
4.2.F-22	Pressure Garments - Protection Against Failure Propagation	N/A		N/A				Not applicable to HW Item design
4.2.F-23	Qualification Fluid	N/A		N/A				
4.2.F-24	Fluid Systems - Design for Flushing and Draining	N/A		N/A				
4.2.F-25	Toxicity - Fluids Contained in Systems in the Crew Compartment	N/A		N/A				Not applicable to HW Item design
4.2.F-26	Atmospheric Pressure and Composition Control	N/A		N/A				Not applicable to HW Item design
4.2.F-27	Liquid or Gas Containers - Verification of Contents	N/A		N/A				Not applicable to HW Item design
4.2.F-28	Use of Halogen Method for Coolant System Leak Detection	N/A		N/A				Not applicable to HW Item design

	CERTIFICATION METHODS	ACCEPTANCE PROCEDURES		QUALIFICATION PROCEDURES			
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S	: Similarity	AVT : Acceptance Vibration Test		FT : Functional Test		QSWTP : Qual. Software Test Procedure	
D	: Demonstration	F/C : Fit-Check					

Paragraph No.	REQUIREMENT	ACCEPT. Method	ACCEPT. Procedure	QUAL. Method	QUAL. Procedure	VERIFICATION DOCUMENT	(O) (X)	COMMENTS / HARDWARE CONFIGURATION
4.2.F-29	Filter Protection of Active Fluid Components	N/A		N/A				
4.2.F-30	Pressure Relief for Pressure Vessels	N/A		N/A				
4.2.M/P-1	Material Selection, Review, and Drawing Sign-off	N/A		A	See Comment		O	Review HW Item Material Cert. Rpt.
4.2.M/P-2	Flammability of Wiring Material	N/A		A	See Comment		O	Review HW Item Material Cert. Rpt.
4.2.M/P-3	Toxicity of Materials Used in Crew Compartments - Wire Insulation, Ties, Identification Marks, and Protective Coverings	N/A		A	See Comment		O	Review HW Item Material Cert. Rpt.
4.2.M/P-4	Metals and Metal Couples - Restriction on Use	N/A		A	See Comment		O	Review HW Item design and drawings
4.2.M/P-5	Solutions which contain Ethylene Glycol - Requirements for Silver Chelating Agent	N/A		N/A				Not applicable to HW Item design
4.2.M/P-6	Toxicity - Requirements for Nonmetallic Materials Proposed for Use within Crew Compartment	N/A		A	See Comment		O	Review HW Item Material Cert. Rpt.
4.2.M/P-7	Material Detrimental to Electrical Connectors	N/A		I	See Comment		O	Review HW Item design and drawings, material certification memo
4.2.M/P-8	Leak Detectors - Wetting Agents	N/A		N/A				Not applicable to HW Item design
4.2.M/P-9	Breathing Systems - Requirement to Test for Mercury Contamination	N/A		N/A				Not applicable to HW Item design
4.2.M/P-10	Liquid Locking Compounds, Restrictions, and Controls	I	PDA	I	see PDA		O	Ref. assembly TPS and acceptance data pack (ADP)
4.2.M/P-11	Pressure Vessel Documentation	N/A		N/A				
4.2.M/P-12	Multi-layer Blanket Bake-Out	N/A		N/A				Not applicable to HW Item design
4.2.M/P-13	Pressure Vessel Design	N/A		N/A				Not applicable to HW Item design
4.2.M/P-14	Silicate Ester Coolant System Design	N/A		N/A				Not applicable to HW Item design
4.2.M/P-15	Mercury - Restriction on Use	N/A		N/A				Not applicable to HW Item design
4.2.M/P-16	Restriction on Coatings for Areas Subject to Abrasion	N/A		I	See Comment		O	Review HW Item design and drawings
4.2.M/P-17	Radiographic Inspection of Brazed and Welded Tubing Joints	N/A		N/A				
4.2.M/P-18	Etching Fluorocarbon Insulated Electrical Wire	N/A		N/A				
4.2.M/P-19	Spacecraft Material - Restriction on Use of Polyvinyl Chloride	N/A		A	See Comment		O	Review HW Item design and drawings, and materials cert. memo
4.2.M/P-20	Titanium or Its Alloys - Prohibited Use with Oxygen	N/A		N/A	See Comment		O	Review HW Item design and drawings
4.2.M/P-21	Beryllium - Restricted Use within Crew Components	N/A		I	See Comment		O	Review HW Item design and drawings
4.2.M/P-22	Brazed Joints - Identification Marks	N/A		N/A				Not applicable to HW Item design
4.2.M/P-23	Pressure Vessels - Materials Compatibility and Vessel Qualifications Tests	N/A		N/A				
4.2.M/P-24	Cadmium - Restriction on Use	N/A		N/A				
4.2.M/P-25	Pressure Vessels - Nondestructive Evaluation Plan	N/A		N/A				
4.2.M/P-26	Repair of Sandwich -Type Structures	N/A		N/A				Not applicable to HW Item design
4.2.M/S-1	Equipment Containers - Design for Rapid Spacecraft Decompression	N/A		I	See Comment		O	Review HW Item design, drawings
4.2.M/S-2	Alignment of Mechanical Systems	N/A		N/A				
4.2.M/S-3	Wire Bundles - Protective Coating	N/A		I	FT		O	Review HW Item design, drawings
4.2.M/S-4	Hatches - Repeated Use	N/A		N/A				Not applicable to HW Item design
4.2.M/S-5	Threaded Fittings - Restrictions on Release of Particles and Foreign Material	N/A		I	PDA		O	Review HW Item design and drawings
4.2.M/S-6	Exposed Sharp Surfaces or Protrusions	I	PDA	I	PDA		O	
4.2.M/S-7	Windows and Glass Structure	N/A		N/A				Not applicable to HW Item design
4.2.M/S-8	Penetration of Inhabited Spacecraft Compartments	N/A		N/A				Not applicable to HW Item design
4.2.M/S-9	Mechanisms	N/A		N/A				Not applicable to HW Item design

HRF WORKSTATION CERTIFICATION MATRIX

CERTIFICATION METHODS	ACCEPTANCE PROCEDURES	QUALIFICATION PROCEDURES		
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Paragraph No.	REQUIREMENT	ACCEPT. Method	ACCEPT. Procedure	QUAL. Method	QUAL. Procedure	VERIFICATION DOCUMENT	(O) (X)	COMMENTS / HARDWARE CONFIGURATION
4.2.M/S-10	Functional Doors that Operate in Flight	N/A		N/A				Not applicable to HW Item design
4.2.M/S-11	Meteoroid Protection Levels for Structures	N/A		N/A				Not applicable to HW Item design
4.2.M/S-12	Spacecraft Recovery Hoist Loops	N/A		N/A				Not applicable to HW Item design
4.2.M/S-13	Lifting and Hoisting Ground Support Equipment Identification	N/A		N/A				
4.2.M/S-14	Structural Analysis	N/A		A	See Comment		O	Review HW Item Stress Analysis Rpt.
4.2.M/S-15	Stainless Steel Tubing - Method of Joining	N/A		N/A				
4.2.M/S-16	Pressure Vessels - Negative Pressure Damage	N/A		N/A				
4.2.P-1	Explosive Devices - Arming and Disarming	N/A		N/A				Not applicable to HW Item design
4.2.P-2	Pyrotechnic Devices - Preflight Verification Tests at Launch Sites	N/A		N/A				Not applicable to HW Item design
4.2.P-3	Wire Splicing	N/A		N/A				Not applicable to HW Item design
4.2.P-4	Explosive Devices - Packaging Material	N/A		N/A				Not applicable to HW Item design
4.2.P-5	Explosive Devices - Identification Requirements	N/A		N/A				Not applicable to HW Item design
4.2.P-6	Protection of Electrical Circuitry for Explosive Devices Employing Hot Bridge wire Initiators	N/A		N/A				Not applicable to HW Item design
4.2.P-7	Explosive Devices - Color Coding Requirements	N/A		N/A				Not applicable to HW Item design
4.3	BONDING CONTINUITY	T	PDA	T	See Comments		O	Qual reqt. fulfilled at PDA.
4.4	CLEANLINESS							
4.4.1	External Surfaces	I	PDA, PIA				O	
4.4.2	Internal Surfaces	I	PDA, PIA	I	PDA		O	Reference Assembly Documents.
4.4.3	In-Flight Cleanliness	N/A		N/A				
4.5	CONSTRUCTION REQUIREMENTS							
4.5.1	MATERIALS AND PROCESSES							
4.5.1.1	General Materials and Processes and Parts Interface	N/A		A	See Comments		O	Qual approval via Cert. Mat. Cert Memo
4.5.1.2	Stress Corrosion	N/A		A	See Comments		O	Qual approval via Cert. Mat. Cert Memo
4.5.1.3	Fracture/Fatigue	N/A		A	See Comments		O	Qual approval via Cert. Mat. Cert Memo
4.5.2	SCREW THREADS	N/A		I			O	Approval of Drawings
4.5.3	FASTENERS	I					O	Reference TPS pulling parts out of bond.
4.5.4	LOCKING DEVICES							
4.5.4.1	Thread Locking Adhesive	I	PDA				O	Inspection at assembly.
4.5.4.2	Lock Wire	N/A		N/A				
4.6	WORKMANSHIP	I	PDA, AVT				O	
4.7	INTERCHANGEABILITY AND REPLACEABILITY							
4.7.1	INTERCHANGEABILITY	N/A		N/A			O	Hardware Specific
4.7.2	REPLACEABILITY	N/A		N/A				Hardware Specific
4.7.3	MAINTAINABILITY							
4.7.3.1	On Orbit	N/A		N/A				
4.7.3.2	Ground	N/A		N/A				
4.8	COLOR							
4.8.1	Stowed Hardware	I	PDA	I	PDA		O	Inspect to Drawings
4.8.2	Rack Mounted Hardware	I	PDA	I	PDA		O	
4.9	NON IONIZING CONDUCTED RADIATION							
4.9.1	Emission			A	See Comment		O	Hardware Specific Rack Requirement
4.9.2	Susceptibility	N/A		N/A				Hardware Specific
4.10	ILLUMINATION	N/A		I	See Comments		O	Use B9 Mockup. Subjective approval of Eng. and QA via TPS.
4.11	GROUND HANDLING							
4.11.1	GROUND HANDLING LOAD FACTORS			A	SA		O	If required, within handling/shipping container.
4.11.2	SHOCK CRITERIA - RACK			A	SA		O	If required, within handling/shipping container.

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4.11.3	BENCH HANDLING - STOWED	N/A	N/A	N/A	N/A			N/A
4.12	USEFUL LIFE							
4.12.1	OPERATIONAL LIFE			A	See Comments		O	MTBF Report
4.12.2	SHELF LIFE	A		A	See Comments		O	A = ADP/Q=Limited Life
4.12.3	LIMITED LIFE	A		A			O	Limited Life
4.13	EEE PARTS REQUIREMENTS							
4.13.1	GENERAL REQUIREMENTS			A	See Comment		O	Parts use and list submitted to EEE Parts Group
4.13.2	PARTS SELECTION			A	See Comment		O	Parts use and list submitted to EEE Parts Group
4.13.3	COTS/MODIFIED COTS	T		T	PDA		O	Perform Burn-in/Elevated temperature test, as recommended
4.14	BATTERY REQUIREMENTS			A	See Comment		O	1) Reference common battery cert. pkg., 2) Memo of concurrence from Group (either one or both).
5.0	ENVIRONMENTAL CERTIFICATION REQUIREMENTS							
5.1	GENERAL							
5.2	TEMPERATURE							
5.2.1	OPERATING TEMP	T	ATT	T	QTT		O	65 to 85 degrees Fahrenheit (Air Inlet)
5.2.2	NON-OPERATING TEMP	T	ATT	T	QTT		O	36 to 120 degrees Fahrenheit, with protection if needed.
5.3	PRESSURE							
5.3.1	OPERATING PRES.	I	PDA				O	
5.3.2	NON-OPERATING DEPRESSURIZATION			A			O	
5.3.3	RATE OF CHANGE			A			O	
5.4	HUMIDITY							
5.5	OXYGEN ENVIRONMENT			A			O	
5.6	CONTAMINATION AND WASTE MANAGEMENT	N/A		N/A				
5.7	RANDOM VIBRATION	T	AVT	T	QVT (Rk only)			QAVT will not be performed.
5.8	ACCELERATION			A	SA		O	SAs Rack, Assessment for Stowed. Stowed hardware vibrated in foam in stowed configuration.
5.9	ACOUSTICS EMISSION			A			O	Levels are currently TBD. Tested as engineering evaluation only. Rack Requirement.
5.10	IONIZING/NON-IONIZING NON-CONDUCTIVE RADIATION							
5.10.1	Ionizing							
5.10.1.1	Emission		N/A	N/A				
5.10.1.2	Susceptibility		N/A	N/A				
5.10.2	Non Ionizing							
5.10.2.1	Enmission			T			O	Engineering Evaluation only.
5.10.1.2	Susceptibility	N/A		N/A				

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